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COVER: The 2003 Tucson Show features minerals from the Andes like this spectacular Peruvian rhodochrosite and quartz specimen from the Smithsonian Collection. (Photo by Harold and Erica Van Pelt)

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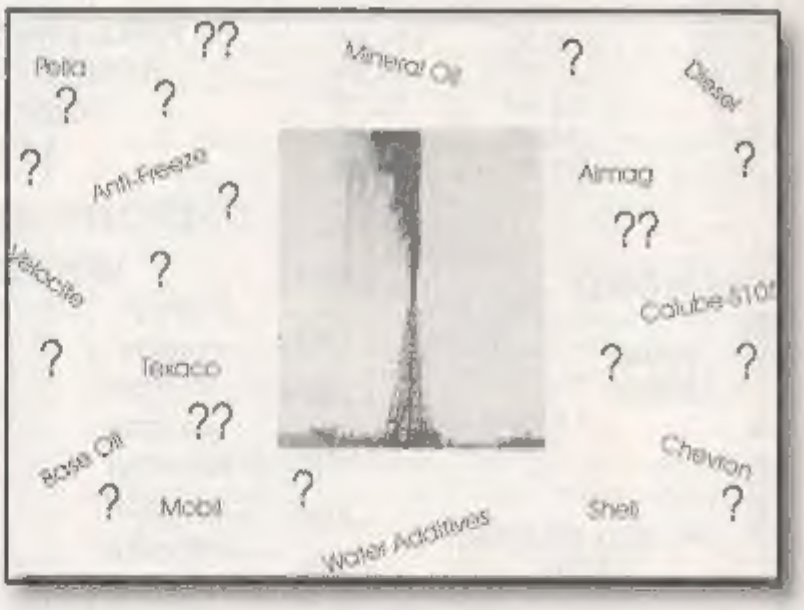
SHOP TALK

by William A. Kappele

Coolant ... Again



I get lots of letters and e-mails from folks who want to know what kind of coolant to use in their saws. More specifically, most of them ask about what lubricant to use, and this is just like fingernails on the blackboard to me. I have written many times about this, but here goes again.

The function of a lubricant is to keep two surfaces from touching. In an automobile engine, for instance, the crankshaft and the main and rod bearings should never touch or they will be destroyed, and the owner will be out a whole bunch of bucks. Oil provides a thin film that keeps the parts from touching. If we were to lubricate our rock saws this way, there would be a thin film of lubricant between the rock and the diamonds on the saw blade. No cutting could take place. In a rock saw, we want the surfaces to touch and for one (the diamond blade) to destroy, in a manner of speaking, the other (the rock).

Of course, there are some parts of the saw that need lubrication. The moving parts of the feed mechanism need lubrication, and usually get it from the oil spray and splash that goes on during the cutting. The primary function of coolant in the lapidary saw, however, is to cool the blade and the rock in the area of the cut. It does this by absorbing heat from both the blade and the rock. Since it is either being splashed around or pumped directly onto the cut, it is constantly being replaced with clean and cool fluid. Some fluids are more capable of carrying on this process than others. Oil is a good conductor of heat, and in fact, a secondary use of oil in an automobile engine is to reduce the heat generated by the combustion process.

Water, too, is an excellent means of dissipating heat. After all, on a hot day, would you rather run through the sprinkler or be doused with motor oil? Seriously, though, water's big drawback is that it promotes that old demon rust. It also has the problem of not clinging like oil and it easily turns to steam and dissipates rapidly. If we could keep the area flooded with moving water, it would work fine, but we would still have the rust problem. We could drain the saw and wipe everything down, then spray the whole works with something like WD40 each time we used the saw, but who wants to put up with that?

Probably the best bet is to use what the maker of your blade recommends. If you have problems, there are a lot of products you can experiment with. If there is no recommendation, you can use products like Texaco's Corvus oil or Almag. Corvus oil used to be the favorite of many lapidaries, but lately the only place I see it advertised is at air shows for making the decorative smoke spewed from airplanes. Shell markets a saw oil called Pella, which is another favorite. Lortone has a mineral oil-based coolant that it recommends for its saws, and other manufacturers have their proprietary formulas. Several companies now make additives so that you can use water as a base. Some lapidaries swear by them, and some swear at them.

Personally, I still use automobile antifreeze (ethylene glycol). It is made to dissipate heat, it contains rust inhibitors, it has lubrication for the water pump shaft, it is cheap, and I like it. Keep it away from pets, though. They like the taste of it, but it can kill them. There is a new version now with a propylene glycol base that is less toxic, but I haven't tried it yet.

Choose one that works for you and have a happy sawing experience.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

PROJECT:

Reticulated SILVER

Stylize Ordinary Sterling for a Bold Lapidary Look

by Sam Howeth and Nova Wells

Enter the words "reticulated silver" into your Internet search engine and you will get a long list of Web sites featuring reticulated silver jewelry for sale. There are also larger pieces of antique reticulated tableware. The ridges and valleys of reticulated metal are not predictable and uniform. It is this very uniqueness that makes them so attractive.

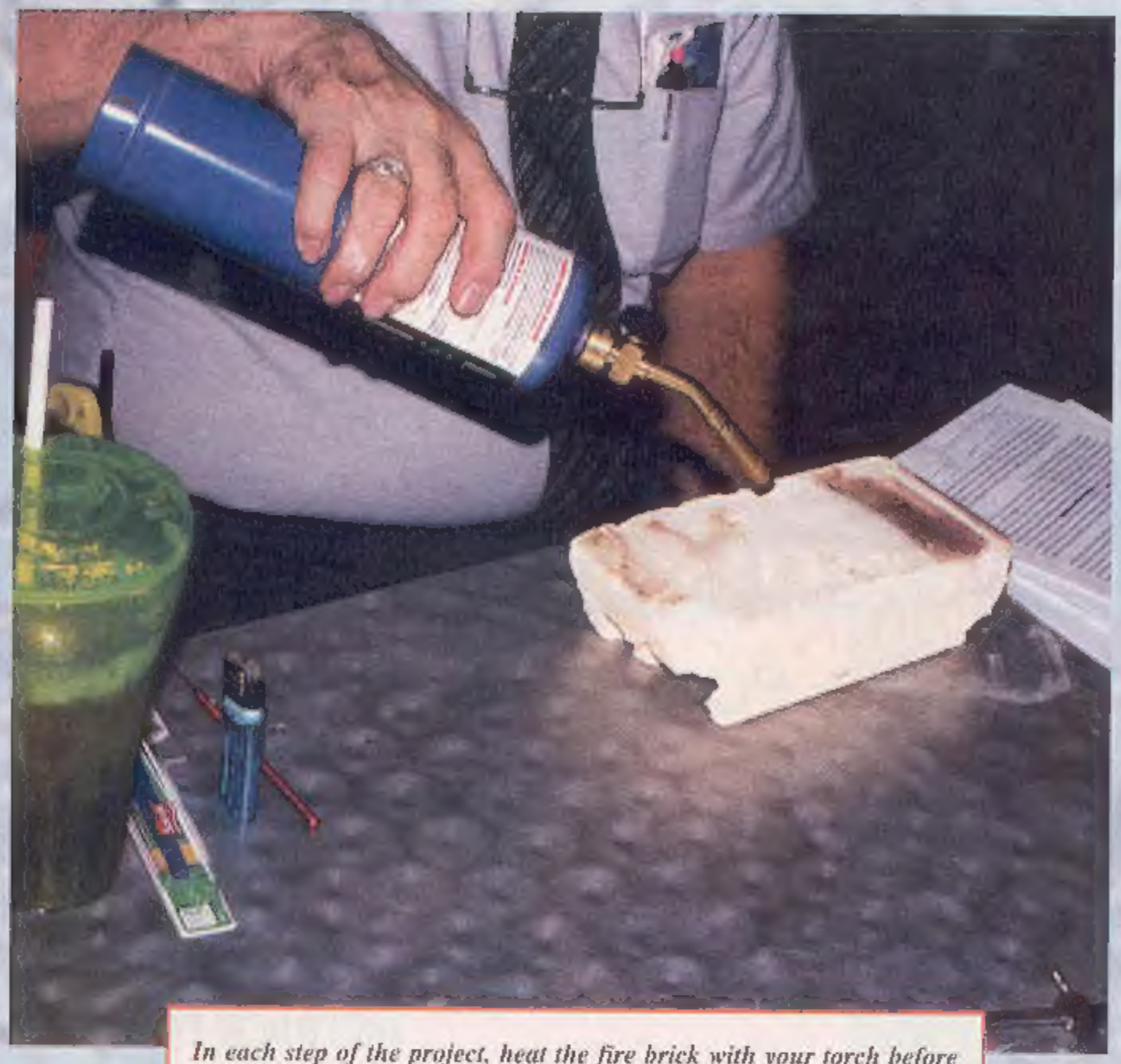
Reticulation is a process that causes metal alloys to form layers which buckle in a decorative manner. It is a process that is temperature critical because one layer of metal in an alloy cools faster than another layer. Many alloys, including brass and 14K yellow gold, can be made to reticulate, but the most useful for jewelry is 82 percent silver and 18 percent copper. Two places where silver of this content can be purchased are Hauser & Miller Co. of St. Louis, Missouri, and Hoover & Strong of Richmond, Virginia.

Shamarodak is the name for reticulated silver in Russia, where it was a natural occurrence for Russian silversmiths using the 820/180 Russian silver standard. In Finland it is called krymppays. Peter Carl Fabergé, whose French Huguenot parents escaped to settle in Russia in 1870, is credited with being the first to deliberately reticulate silver for decorative purposes. The term "reticulation" was first used in the United States in 1961.

Reticulated silver may be sawed, soldered, colored and finished, but it is brittle and is difficult, if not impossible, to form successfully. Any forming should be done before the piece is reticulated. It is a good idea to burnish any edges to be soldered so the solder will not be absorbed by the copper oxide layer.

Equipment:

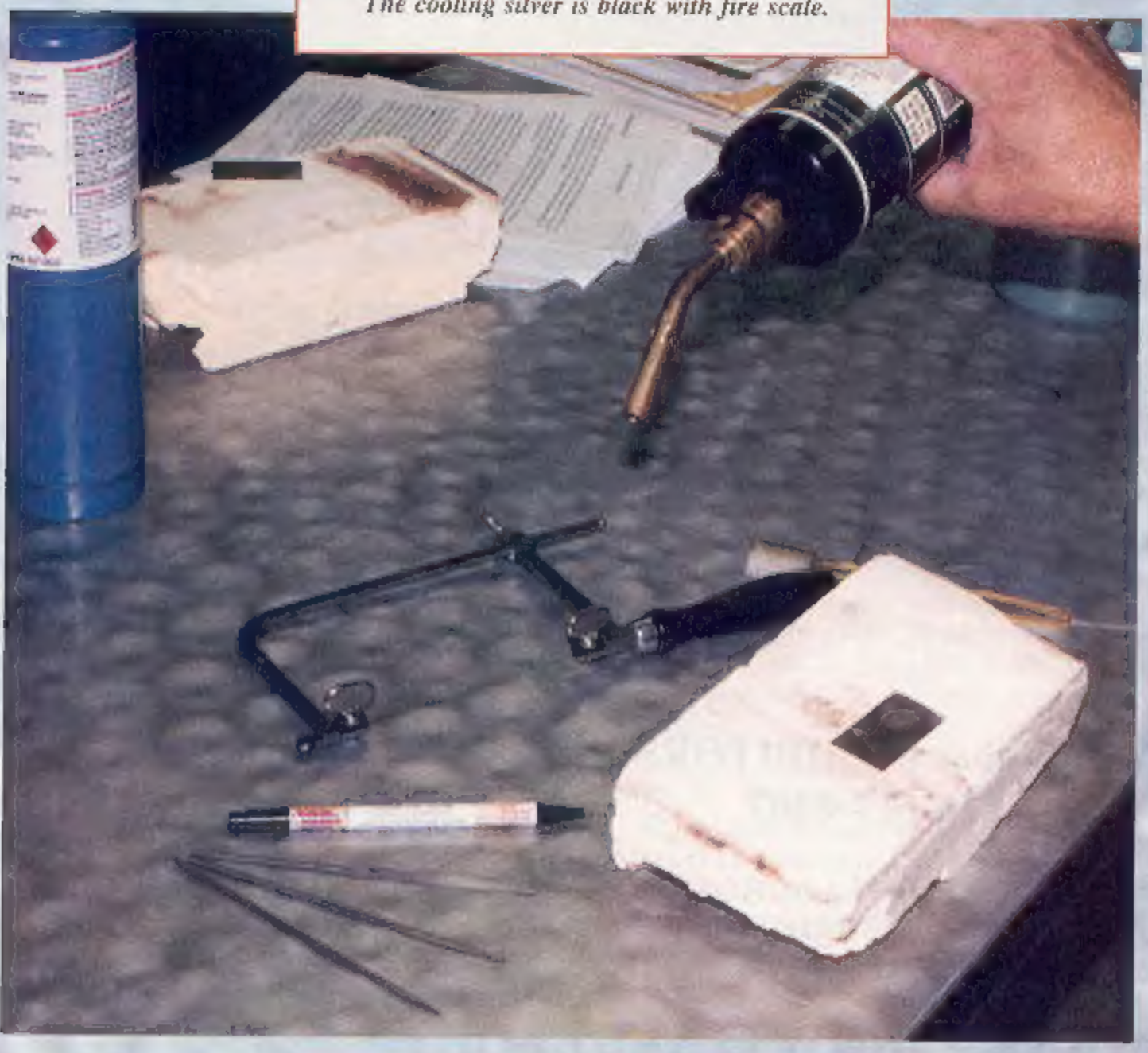
- 820 silver
- Fire brick
- Torch (suitable for soldering)
- Copper tongs
- Pickle
- Soda bath
- Clean water
- Brass bristle brush or steel wool
- Liquid soap



In each step of the project, heat the fire brick with your torch before you place the silver on it. (Photos by Carl and Nova Wells)

When heating the silver, turning the lights down makes it easier to observe the dull red color of the metal.

The cooling silver is black with fire scale.



Three to five separate heat treatments are required in the reticulation process. The first steps can be done by torch or in a kiln, but the final step is done with a torch. Small pieces of thinner gauges (22 to 24) work well with a torch, but large pieces or heavier gauges (16 to 20) will respond better with the use of a kiln. Larger or heavier pieces also need the additional heating treatments.

Step 1

Clean the silver stock and handle only by the edges, since any residue from fingers will affect the process. When using heavier gauges, paint the back and any areas you do not want reticulated with flux. Heat the fire brick before placing the silver on it. Heat the silver to 650 degrees C (1200 degrees F) and hold at this temperature for five minutes, either with kiln or torch. The silver will be a dull red. *If using a torch, do the work in a dim light so the color can be observed accurately.*

Air cool and pickle in hot, fresh Sparex or a 5 percent solution of sulfuric acid. Rinse and then neutralize in a solution of baking soda. Rinse again. After neutralizing the silver, compact the top layer of fine silver by lightly brushing it with a brass brush lubricated with liquid soap, and rinse.

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Pickle removes the outer fire scale layer and shows the fine silver.

A baking soda bath neutralizes the pickle absorbed by the porous copper layer.

Brushing the silver lightly with a brass bristle brush and liquid soap compacts the fine silver.

What you are actually doing is creating layers of copper oxide (fire scale) and fine silver. Pickling will remove the copper oxide from the surface and stabilize the copper oxide layer beneath the fine silver. The baking soda dip is required because the copper oxide is porous and absorbs the pickle.

Hints: Use the oxidizing part of the torch flame. With an acetylene/air torch, use a number 3 or 4 tip. Change to a number 2 tip for Step 4.

Step 2

Repeat Step 1, this time holding the temperature for seven minutes. You are increasing the lower layer of copper oxide, which is the layer that will cool more quickly, forming the ridges and valleys of reticulation.

continued on next page

Reticulated Silver *from page 43*

Move a medium hot flame slowly across the surface of the silver until it turns a dull red, then gradually increase the heat until the reticulation begins.

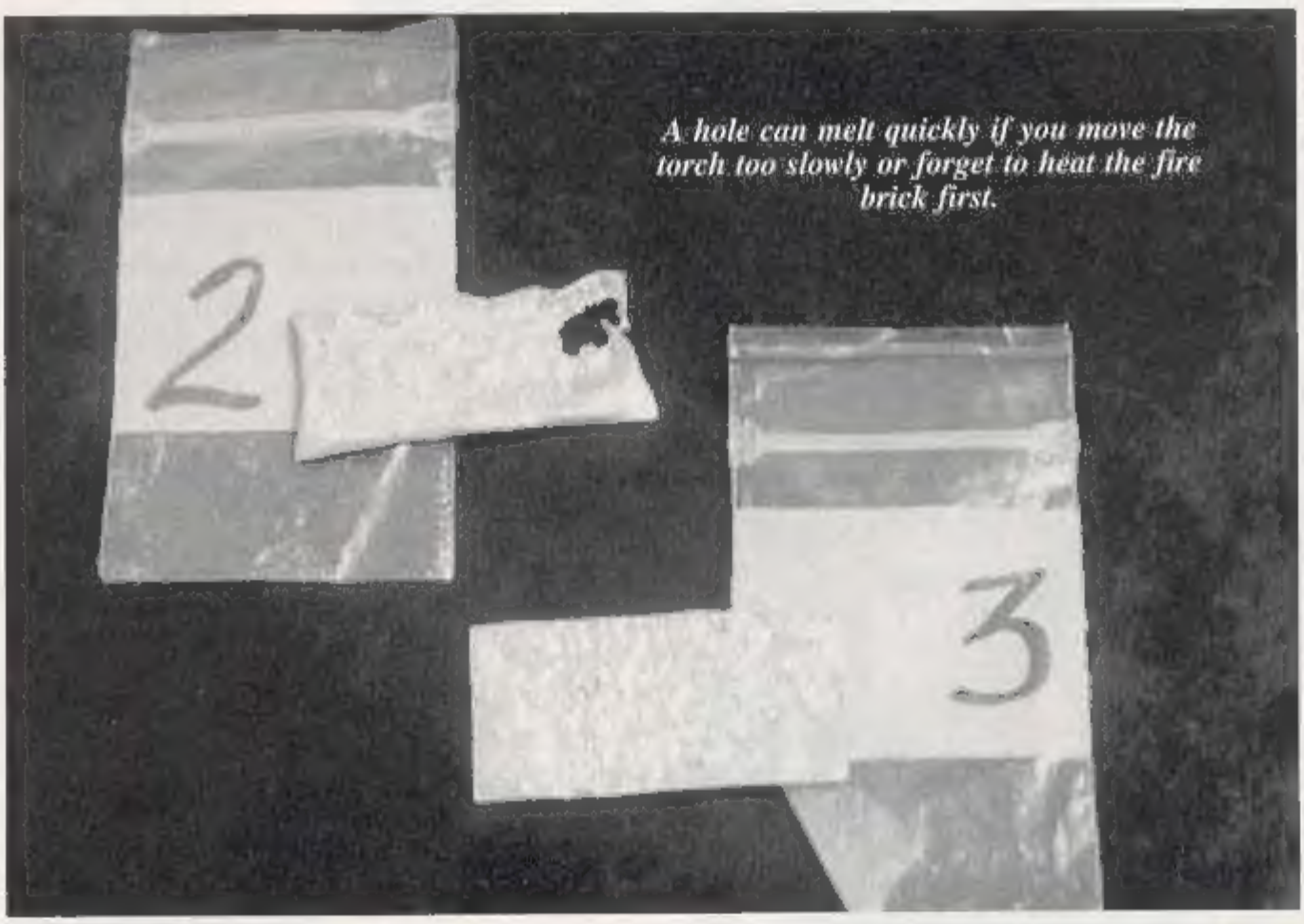
Step 3

Repeat Step 1 with these changes: Hold the temperature for 10 minutes. *Do not brush the surface after neutralizing.*

Step 4

This is the step in which the actual reticulation occurs and must be done with a torch. Begin by heating the soldering block so that heat rises through the metal as well as being heated from above. With a medium hot flame, move the torch slowly across the surface until it turns a dull red. Point the flame vertically, 3 to 4 inches away from the surface and gradually increase the heat. Once the movement (reticulation) of metal begins, move the flame quickly. Do not heat the same area a second time or the ridges will tend to flatten. Horizontal, vertical or circular movements will create different effects. Try to avoid melting the fine silver layer because this will minimize the sharpness of the ridges. *Caution: A hole can melt quickly if the flame is not kept moving.*

When the piece is completely reticulated allow it to cool slightly, then pickle, rinse, neutralize, rinse and wash. The reticulated silver in a finished piece of jewelry can be antiqued or polished with steel wool or a brass brush.



A hole can melt quickly if you move the torch too slowly or forget to heat the fire brick first.

GemsTone

FIELD TRIP

AGATES Abound on the Yellowstone River

by Kenneth H. Rohn

I was making good time in my new GMC pickup. The miles were slipping quickly by as I left the Minnesota border far behind. I was traveling through North Dakota toward the setting sun on U.S. Highway 2. The purpose of this trip was my continuous quest for little-known, out of the way places in which to collect gemstones. I knew full well that I had set a task for myself that was by no means easy, particularly in today's complicated world.

Having recently returned from a successful and most unusual field trip in Manitoba, I was itching to continue my good-luck streak and get my hands on some high-quality lapidary material, particularly agate and silicified wood. If Lady Luck was in my corner, some quality specimens of moss agate would also find their way into my rock bag.

My first stop was Williston, North Dakota, a few minutes' drive away from the Montana border. It had been better than three decades since I collected moss agate of very high quality in the area. At that time, I was the layout man for a new bowling alley being constructed in Williston. On my days off, I'd drive into the hills at the edge of town and spend many leisure hours picking up the most magnificent specimens of moss agate that anyone could imagine. The coloration and dendritic inclusions in those stones would have even surpassed that of the famous Montana variety. One very fruitful area, I recall, was a dry creek bed not far from the city limits that the motel manager told me about. He collected diamond willow limbs along this creek and made furniture and most unusual walking canes from them. I couldn't locate it on this trip. Homes were now in the area and there was no sign of a dry creek.

As was to be expected, things had changed in Williston. The gravel roads and the ditches that I used to collect from no longer exist. Many are now paved. Those very lucrative road cuts and ditches, for the most part, are now a continuation of mowed lawns and are private property. The moral of the story, of course, is: Do it now, don't wait till tomorrow.

Wild asters and agates line the banks of the Yellowstone River at Crane, Montana. (Photos by the author)

If you let your imagination take over, the gold and creamy white coloration of this agate looks like scrambled eggs.

Gravel Beds

The specimens collected on the gravel bars at Crane include chalcedony, Montana moss agate, banded agate, and agatized wood.

My time for this trip was very limited, so I had to move on before exploring further. I'm certain that, during low-water periods, places along the confluence of the Missouri and Yellowstone rivers will prove to be very good collecting sites, especially along exposed gravel beds. Also, it would be wise to explore any gravel pits in the area. I'm sure the potential for finding good quality moss agate is still in the Williston area. So if you're passing through, don't overlook this opportunity.

As in any venture, luck, I believe, plays a large part in the results of a rockhounding trip. My next stop proved the point. I discovered an excellent collecting site not far from the North Dakota line. By following state Highway 16, I came into Crane, Montana, 11 miles southwest of Sidney, in the early afternoon. Crane is a small community adjacent to the Yellowstone River. From this town, the river is but a stone's throw away. Being a stranger to the area, I couldn't find an access road to the river. I had turned around after reaching the end of town and was heading east when I decided to check the road atlas once more. Details on these maps are not what one would desire in a situation like this.

When I stopped, I noticed a man driving a pickup in the field next to me. He pulled up and stopped. People are for the most part, very friendly here in Montana. He opened his window and asked me if I needed help. I told him that I was looking for a way to get down to the river and that I was looking for agates. (Most everybody in these parts knows about agates.) It couldn't be more than a mile or so away. He told me to turn around and look for the Seven Sisters Fishing Access road at the other end of town. That road leads to the river.

I found the fishing access sign and followed the narrow gravel road for quite a ways till I came to a "T." No sign points to the fishing access. Which way to go? The river at this point is not in sight. I then noticed another pickup on the road leading left and decided to follow it. When the truck stopped, I pulled up and got out, and struck up a conversation with the three men in the vehicle. They told me they were about to go fishing and asked what I was doing there. I told them I was looking for agates. One of the guys spoke up and asked what size agates was I looking for. With a sudden start, I remarked that it really didn't matter. I'd be happy with the opportunity just to be able to search for some. He said, "Well, you'll find plenty of all sizes in those gravel beds. It's just down the road a piece." They told me to continue on this road and I'd see the fishing access point in a few minutes. As a parting thought, they told me that I'd see gravel beds as far as the eye can see. They weren't exaggerating one iota.

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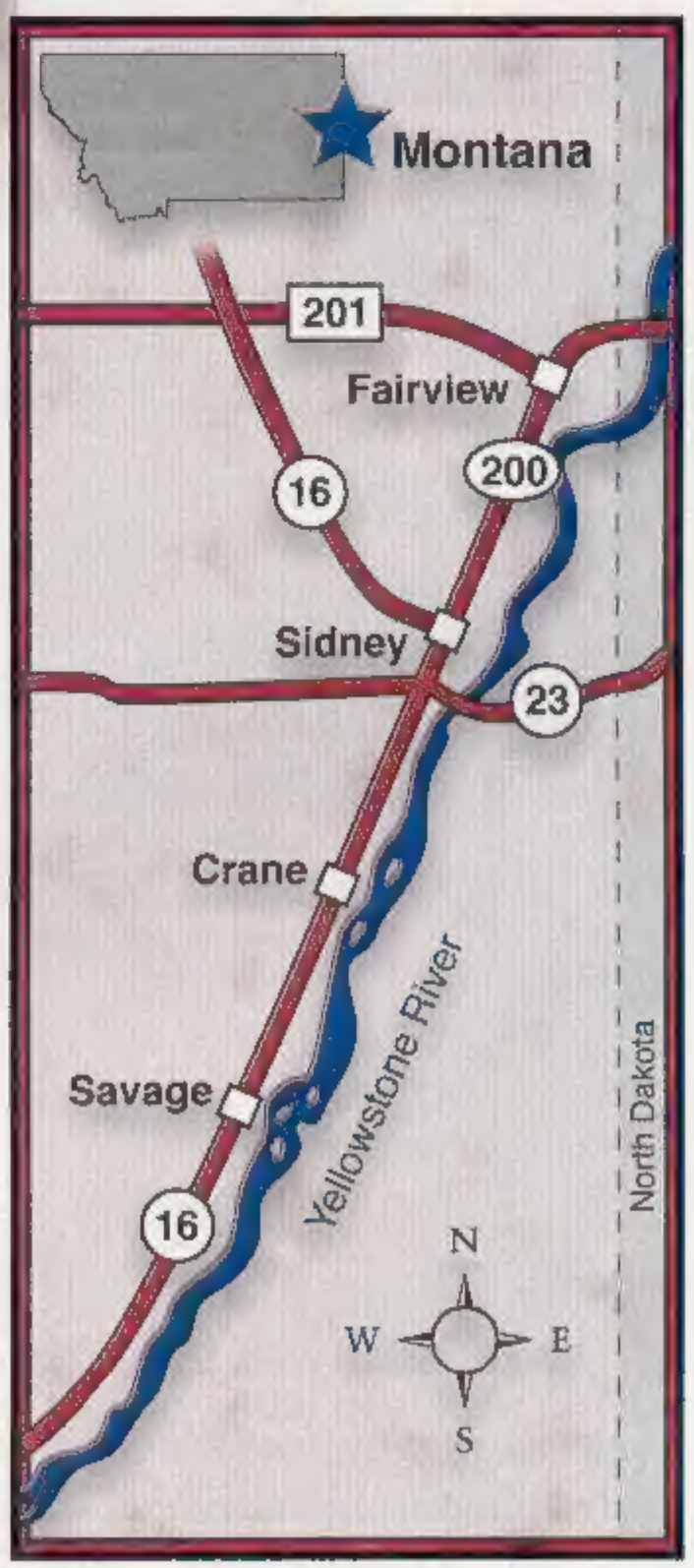

Gemstone Gravel Beds *from page 53*

Those gravel bars looked so inviting, they seemed to draw me like a magnet, but I was hungry. I had been on the road for several hours and it was well past my lunch break. I had recently crossed into the Mountain time zone and had gained an hour, but there was no arguing with my stomach. I made coffee and had a sandwich before going out.

The Yellowstone River at this point is rather calm and subdued, not like some of the areas that I had visited on other trips. It tends to get a bit wild farther upstream, even during low-water times. The most violent periods in my estimation are during spring run-off, or after a heavy rainstorm, so these times are not good as far as we rockhounds are concerned. The bars that are exposed during low-water summer and fall months may be under water, or at least partially so, in the spring.

At the landing, there are gravel bars on both sides of the river, which is at least 300 feet wide here, and moving at a good pace, but without any rapids or white water. As a matter of fact, as I write this, I recall looking out my camper window parked under the huge cottonwoods, at a placid, serene stream. The trees on the far shore were reflected on the glassy, mirrorlike surface, making for a most picturesque setting.

Believe me, the gravel bars here are something to behold. Words do not do them justice. They seem to go on forever. I would dearly have liked to investigate those on the other side. They probably have not been searched much, due to the difficulty in reaching them. A boat would be the only answer. I believe, however, the other shore is private property.

But I was more than content where I was. The bars on my side of the river are wider than the river itself in a few places. I estimated the bar I was standing on to be at least 500 feet wide. I had it all to myself at the moment.

Except for some fishermen whom I met at the landing, no other people were in sight. I did talk to a family later that afternoon who were searching for gemstones. One of the boys had made a science of it by driving his miniature four-wheeler on the bars looking for agates. I don't know if he found any, but he did a lot of starting and stopping along the way.

As I've so often said, the farther one walks away from the vehicle, the better the picking will be. Yet, by the same token, that rock bag will get mighty heavy before getting back to the car. Contrary to the above statement, I did find a few nice stones close to the parking area. Most likely, they were overlooked due to the immense search area here.

From hard-earned experience, I've learned to walk the distance I intend to search, then turn around with an empty rock bag—or at least partially so—and begin collecting on the way back. It's very difficult to pass up a good stone knowing full well that I may never find it again, so some rocks do get into the bag outward bound.

For a great side trip that can be an adventure in itself, Theodore Roosevelt National Park is well worth the time spent. It consists of three units: The North Unit, approximately 55 miles south of Williston, North Dakota, on U.S. Highway 85; the Elkhorn Ranch Site, farther to the south; and the South Unit, adjacent to Medora on Interstate 94.

Here, you can witness the Dakota Badlands as Teddy Roosevelt once saw them. The spires and banded hills change color with the daylight hours and are especially spectacular at sunset. The scenic road in the North Unit takes you right through some of the most beautiful vistas in the park.

While I was there, I took a hike on the Buckhorn Trail, and later, on the self-guided Nature Trail. The prairie dog town situated on the Buckhorn Trail is most enjoyable. The Nature Trail is also well worth the time spent.

The Elkhorn Ranch Site, I was told, is rarely visited. Nothing remains today of the ranch that once stood on the bank of the Little Missouri River. One important incident in Roosevelt's life is the fact that he gained health and vigor in the Badlands. He once made the comment that he would never have been president of the United States had it not been for his time spent in the Dakota Territory.

The South Unit is the largest, with Medora as its focal point. Spending quality time here requires at least a few days to be able to enjoy it. This park is dedicated to one of the great men in the history of our country. It's well worth seeing.

On my first trip on the bars (I made several), I had barely scratched the surface when my bag began to tug at my hip. It's a rather small rock bag. It actually serves two purposes; I also use it as my pouch while metal detecting. It holds the goodies as well as the trash, which I later discard in the nearest dumpster.

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ROCK SCIENCE

by Steve Voynick

Apatite and Phosphate Rock

by Steve Voynick

Many mineral collections include fine crystals of apatite—attractive hexagonal prisms that are usually green and somewhat beryl-like in appearance. Apatite, which is calcium fluorine chlorine hydroxyl phosphate, has the chemical formula $Ca_5(PO_4)_3(F,Cl,OH)$. Within the apatite molecule, the amounts of calcium (Ca) and phosphate (PO_4) are fixed, but the relative amounts of fluorine (F), chlorine (Cl), and the hydroxyl group (OH) can vary considerably. Therefore, the name apatite refers not to a single mineral, but to a group of minerals: fluorapatite, chlorapatite, and hydroxylapatite, depending upon whether fluorine, chlorine, or the hydroxyl group predominates.

Although fine, well-developed apatite crystals are relatively rare, apatite is nevertheless by far the most common phosphate mineral in the Earth's crust and one of great economic importance. That's because of the abundance of a cryptocrystalline apatite variety called collophane. Collophane is widely distributed in many igneous, metamorphic, and sedimentary rocks, but is most concentrated in phosphate rock, a sedimentary rock that is a commercial source of elemental phosphorus and the basic raw material used to manufacture fertilizers.

Phosphate rock originates from the process of marine deposition. In certain ancient, relatively shallow seaways, the upwelling of nutrient-rich, cold water created an explosion of plankton and other tiny invertebrate marine organisms. These invertebrates lived and died at such a rapid pace, and in such enormous numbers, that the phosphatic materials in their soft tissues were sometimes unable to dissolve in seawater, sinking instead to the sea bottom in huge quantities where they mixed with and became preserved in other sediments. These sediments eventually lithified into phosphate rock, an indefinite mixture of cryptocrystalline apatite, calcium carbonate, and silica. Phosphate rock is like limestone in appearance and usually gray or dark gray. It is technically classified as phosphate rock when it contains enough apatite to make it a valuable commercial source of phosphate.

Phosphate rock is mined in large open pits, then crushed and ground to the consistency of talcum powder. The crushed rock is mixed with sulfuric acid to change the insoluble apatite into a hydrated mono-calcium phosphate known by the industrial term superphosphate. In a final step, superphosphate is filtered to remove calcium sulfate and other impurities, then dried, sized, and prepared for shipping.

Superphosphate is far richer in phosphate than the original apatite, containing about 20 percent available phosphate. It is soluble in water and ready for agricultural use in standard nitrogen-phosphorus-potassium (N-P-K) fertilizers. Superphosphate is also the basic feedstock for the production of elemental phosphorus and such chemicals as phosphoric acid, which are, in turn, feedstocks for manufacturing insecticides, matches, pyrotechnics, and many other products.

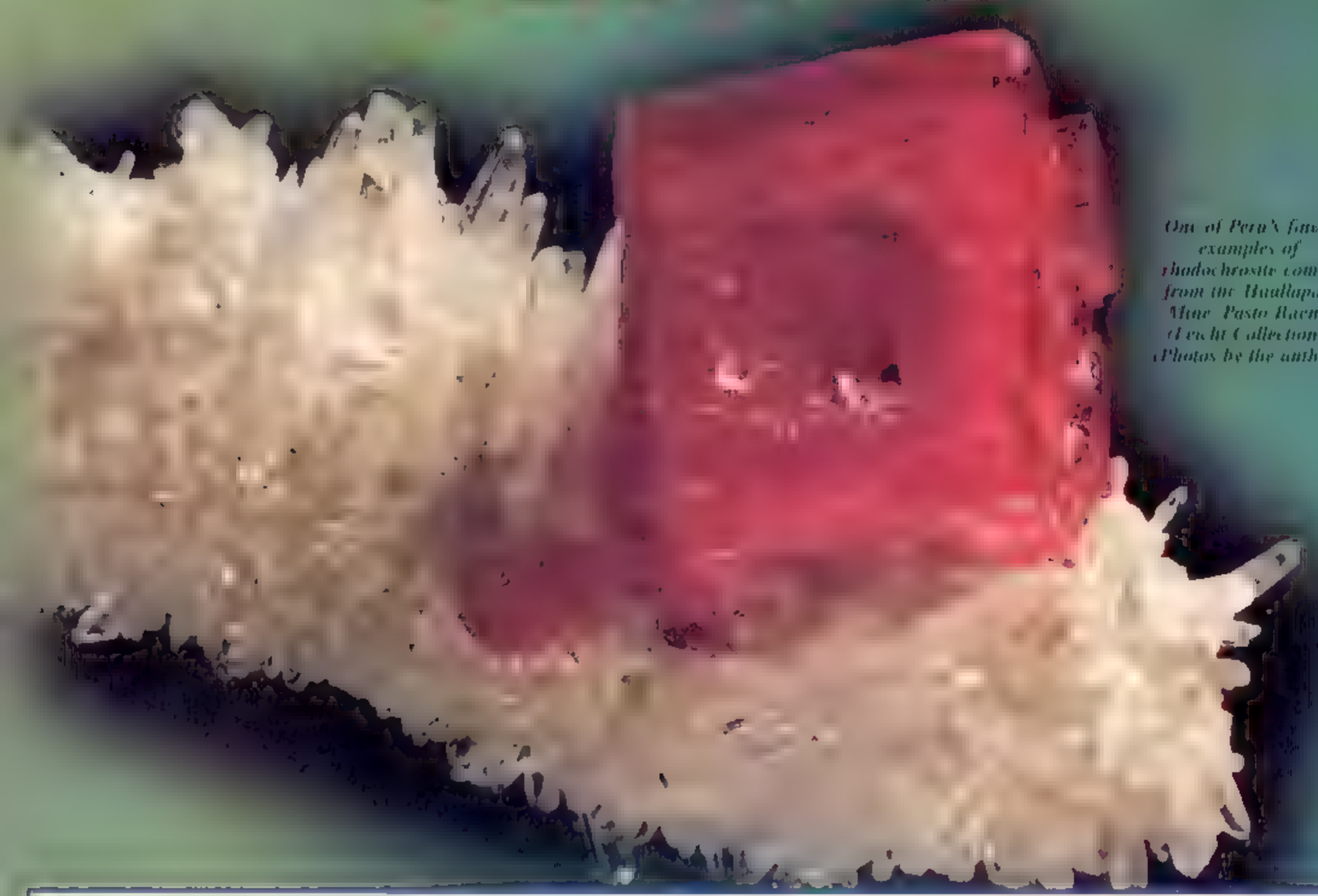
Until the 1970s, large amounts of superphosphate were converted into trisodium phosphate, a compound used extensively in laundry detergents and water softeners. However, laundry detergent use of phosphate has been greatly reduced since the 1970s, after studies revealed that phosphates in wastewater had serious adverse environmental effects. Since phosphate is the primary nutrient of algae, large volumes of phosphate-rich laundry wastewater can cause algae blooms that kill lakes and rivers by drawing off oxygen needed by other forms of aquatic life.

Worldwide, more than 140 million tons of phosphate rock are mined each year and processed into superphosphate worth more than $4 billion. The United States is the world's largest producer of phosphate rock, mining 40 million metric tons per year, mostly from mines in Florida, North Carolina, Idaho, and Utah.

Apatite is literally a mineral we take with us wherever we go, because it's the primary mineral component of bones and especially of teeth in all vertebrate animals. Of the three types of apatite, fluoro-, chloro-, and hydroxyl-, fluorapatite is the hardest, and the reason behind the fluoridization of drinking water and toothpaste. When increased levels of fluoride contact the teeth, some of the chloro- and hydroxyl-types of apatite in the teeth are converted to fluorapatite, the most decay-resistant form of apatite.

So whether we're referring to teeth, an indispensable component of fertilizer, or a collectible greenish, beryl-like mineral crystal, we're still talking about apatite.

Minerals of the Andes



One of Peru's finest examples of rhodochrosite comes from the Huallapon Mine. Pasto Bueno (Frecht Collection). (Photos by the author.)

Tucson Goes South for Its Show Theme

by Bob Jones

Most major mineral shows choose a yearly theme these days. The East Coast Show uses an individual collector to create a theme. The Mineralogical Society of Southern California, which held its most recent show in the Natural History Museum of Los Angeles County, used "Minerals of California" for its theme. The Tucson Gem & Mineral Show, whose first theme in 1964 was "the Southwest," has chosen "Minerals of the Andes" for 2003. In 2004, which will be the 50th Tucson Show, the theme will appropriately be "Gold."

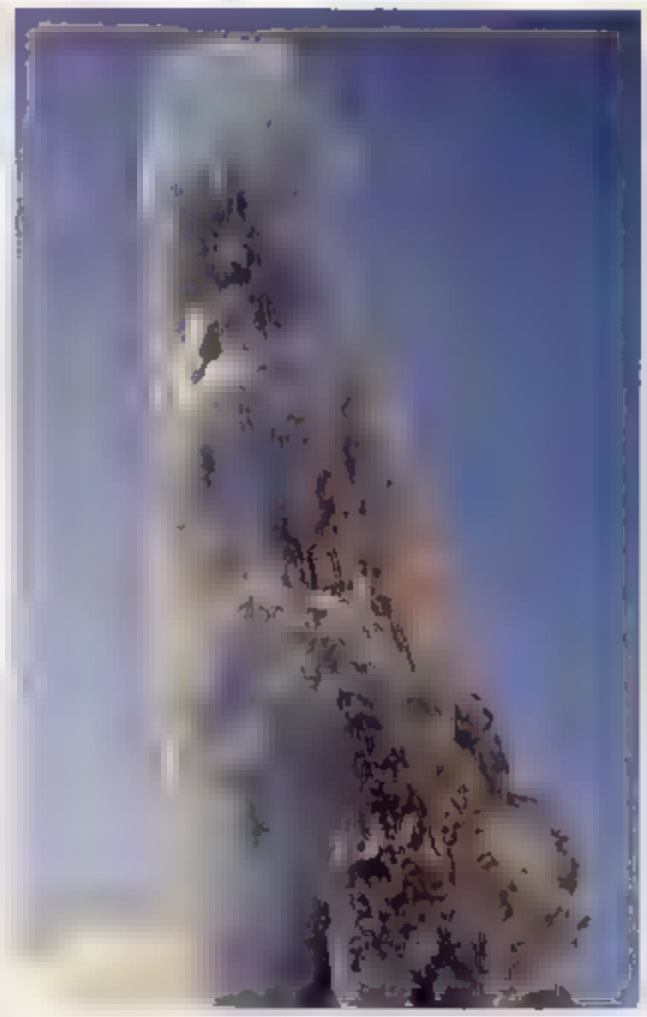
The Andes Mountain chain is the largest in the world and is rich in gems and minerals. A number of the mountains are volcanic, but because of plate tectonic movement there are plenty of faulted and folded mountains, some of which are well endowed with hydrothermal vein systems rich in sulfides and their accompanying gangue minerals. No wonder the Tucson Show will be featuring a great variety of beautiful inorganic creations from this vast mountainous region.

We take the name Andes for granted, but its history goes back to the Quechuan word anti, which means copper. That should not surprise you. From the dry Chuchiquamata Chilean desert to the highest mountains in the range, a host of metals like copper, tin, gold, iron, silver, lead, platinum and mer-

Sharp red hubnerite next to a fine quartz crystal from the Huallapon Mine (Halpern Collection).

fied remains of an ancient native miner who had been crushed when his tunnel collapsed while he was gathering copper minerals. Found with him were his leather collecting bag, a stone hammer, and samples of the copper minerals he was digging. There he lay in the classic rockhound position, on his side with arms outstretched, hammer close to his hand. How many times have I been in that position to get a fine specimen!

The entire assemblage mummy, implements and all was trumpeted in the New York papers as "The Copper Man" when he was brought to the American Museum of Natural History for display. You can see him there today. However, immediately after he was first put on display, he was removed and stored, as his appearance caused something of a problem. From the newspaper label "Copper Man," folks who went to view him had the



The world's finest krohnkite specimen comes from Chuquicamata, Chile (Natural History Museum of L.A. County).

This delightful rhodochrosite stalactite is from Catamarca, Argentina

The world's finest specimen of phosphophyllite from Potosi, Bolivia, is now in the Museum Trust.

cary can be found. Most productive and better known are the Bolivian tin mines, the emerald mines of Colombia, and the huge copper deposits of Chile. Add to that the very special deposits of marvelously patterned rhodochrosite in Argentina and the oval, neon gem ametrine in Bolivia, complemented by a large assortment of metal mines in Peru, Chile, Bolivia and Colombia.

Gold and emeralds were mined in the Andes long before the arrival of the Spaniards. In fact, when the Spaniards arrived and began raiding the land for gold wealth, they were sometimes fooled because the indigent people had learned how to smelt and cast copper and plate it with gold. So when the Spaniards thought they were grabbing the "gold ring," they were sometimes really getting lots of copper with a little gold attached. So, copper was not only being gathered, but smelted and shaped into objects.

The largest copper deposit in South America and perhaps the world is the huge open pit mine at Chuquicamata, Chile. Born in a vast, dry region at the foot of the Andes, Chuqui, as it is called, is rather unique in that most of the secondary copper minerals produced there are unlike what other deposits produce. Instead of forming lots of carbonates and oxides of copper, this deposit has produced a pleasant array of uncommon copper species like atacamite, brochantite, natrochalcite and krohnkite.

Proof of the mining of copper was brought home starkly in the 1920s in the Atacama region of Chile when modern mining broke into an ancient pre-Spaniard mining tunnel and uncovered the mummi

only when the museum pulled our early rockhound off display. But like a bad penny, he has turned up again as a display, and rightly so since he and his regalia are a fine example of an early South American copper miner as he worked.

Today, because most of the ore deposits in the Andes are at extremely high altitudes, the miners are largely trained locals who can handle working vigorously in the thin air at 10,000 to 12,000 feet. Chewing cocoa leaves is one way of dealing with the exhaustion and sometimes pain these doughty miners endure. From my own experience, when I get into the high Rockies at 11,000 feet and work vigorously, it can get rough. It takes time to adapt, and until then minor nosebleeds occasionally occur and shortness of breath is a way of life!

So what do these high Andes produce that would interest collectors? For the lover of gems, Colombia produces the finest and greatest amount of gem emeralds in the world. Ancient artifacts containing emeralds were the property of chieftains before the Spaniards arrived. With their coming, the entire world was introduced to "green fire." Potentates the world over enjoyed the fruits of Spanish slave labor. The Spaniards traded emeralds to the Near and Far East to get the necessities for making war with countries such as England. Many royal jewels, such as the crown of the Shah of Iran, feature Colombian emeralds. When you visit the Tucson Show, you will undoubtedly see jewelry containing such emeralds. My friend Jose Vesga will bring a fine display of gem and natural emeralds from his mine in Muzo, Colombia.

continued on next page

Andes *from page 61*

Ametrine is another gem you'll see at Tucson. This remarkable natural twinning of citrine and amethyst from Bolivia was first thought to be a synthetic or fake gem. But researchers went to the mine near the Bolivia/Brazil border and discovered the gem crystals in situ.

The mine is named for Princess Anahi of the Ayoreos tribe. She was married to a conquistador who was the first European to see what we now call ametrine. There were sporadic appearances of ametrine beginning over a century ago. Then it was actually credited to Brazil. Finally, gem material started to appear in some quantity about 40 years ago, and 10 years later serious mining commenced. Scientists did their best to investigate these lovely, large bicolor crystals and some even visited the site to assure themselves of the genuineness of the ametrine. Large amounts of superb ametrine were imported and turned into beautiful gems, which caught on instantly. When you visit the Tucson Show you'll see some stunning ametrine jewelry. My favorite piece is a gold cocktail ring holding a hefty, stylized, faceted bicolor gem weighing in at 78 carats. Look for it!

As beautiful as gem emeralds and ametrine are, my favorite cabbing material from the Andes is rhodochrosite from Catamarca, Argentina. This high mountain deposit has produced remarkable banded red rhodochrosite, most of it in the form of stalactites and stalagmites. Along with the pink to red carbonate, tan to dark-brown sphalerite is sometimes found in stark contrast to the rhodochrosite. Cut across the grain, these most unusual cave formations provide colorful slices of the mineral that make choice decorator pieces. The carving experts at Idar-Oberstein love to work with this variegated pink to red material, carving flamingoes, other birds and an assortment of exotic shapes. Small pieces showing banding of different shades of pink make wonderful jewelry stones, so this material has broad application in the display and jewelry world. The amount of this material that came forth in years past was so great that simple things like ashtrays, bookends, handles for cutlery and the like were commonly seen at shows. Today, mining in Catamarca has brought this lovely gem back to the fore. At Tucson you'll see this wonderful pink to red-banded material, but I want it treated with greater respect now as it is used primarily in fine intarsia and delicate carvings, and as free standing gem decor pieces.

The minerals from the Andes run the full range that you would expect from surface metal mines. The Peruvian mines are rich in ore minerals of copper, lead and zinc and superb crystallized examples of these metal compounds will be an important part of the Tucson Show. For example, several mines in Peru produce spectacular pyrite

The Inquisition Necklace (Smithsonian Institution) is composed of emeralds that were probably mined by Spaniards at Muzo.

crystal groups. These appeared on the specimen market in the 1960s as sharp, bright, octahedral crystals from Huanzala and elsewhere in Peru. Imagine superb octahedral pyrites in crystal masses weighing up to 250 pounds! Of course choice miniature and cabinet specimens were abundant and much prized by collectors. Fine specimens are still around, but are not as abundant as they were 40 years ago.

Huanzala has also produced some wonderful fluorites as a byproduct of mining. These are not just ordinary cubes of this calcium fluoride, though relatively uninteresting green octahedrons are encountered. The most interesting fluorite specimens from here range from bright "hot" pink to a weak pink to colorless. Amazing specimens up to a foot across with individual crystals closely packed on matrix have come out of this sizable ore body. In a few cases the pink octahedrons hold a nice green internal "ghost" to a crystal, a lovely zoning that makes them even more appealing.

In contrast to the already mentioned rhodochrosite from Catamarca, which only occurs as massive banded material, the mines of Peru also yield superb rhodochrosite in bright pink to red crystals, usually perched on glassy quartz. The largest crystal of rhodochrosite from Peru I've ever seen was displayed at the Tucson Show some years ago. It measured over a foot on an edge, a huge single rhombohedron with etched faces. It wasn't particularly pretty because of the etching, but it sure was impressive as a giant crystal.

The crystallized rhodochrosites you're apt to see at the show this year are sharp gemmy rhombs, some with slightly dipped faces, sitting on crystallized quartz. Large singles are attractive if the color is even and the faces clean. The finer pieces come from the Santa Isabel vein at the Huallapon Mine in Pasto Buena. My favorite is in the personal collection of Wayne and Dona Leicht: a 6-inch-high stalactite of quartz crystals with a single nearly 2-inch perfect rhomb of delicious, soft pink rhodochrosite stuck to its side.

The Pasto Buena district has produced a wonderful selection of species. Fine specimens came out of this area long before World War II. Gemmy specimens of yellow-green sphalerite, sharp textbook crystals of tetrahedrite, and thick deep-red huebnerite blades intermingled with quartz are particularly attractive. Some of the finest arsenopyrites I've ever seen have come from this district. Some blades were up to 2 inches wide and 2 inches long. Others are several inches long, striated, and very sharp. The ones I like best come with bright water-clear quartz, some of which are Japan law twinned. The huebnerites are also associated with good quartz, which makes for showy display specimens. The better source for these is Casapalca in the Junin Province. Some rare species, like hutchinsonite, show up in the sulfide mines of Peru, as well. For a short period of time superb orange-yellow orpiment crystals were common from Casapalca. The crystals are thick with slightly curving faces often slightly altered on the edges, but still very impressive for the species. Some of the thickest, heavily striated crystals of enargite I've ever seen come from here, as well. So Peru has been a ready source of very fine display specimens in the last couple of decades. The Tucson Show displays containing Peruvian minerals should be pretty nifty.

Bolivia has certainly been an important source of fine minerals aside from ametrine, particularly cassiterite from Llallagua, located in the high planar region. And then there is Potosi, one of the great silver mines in the Western Hemisphere. Mining engineer and mineralogist Dr. Mark Bandy worked at Llallagua for 11 years, and many of the location's early specimens came to light as a result of his work. Bandyite, a mineral he discovered in Chile, is named for him. He not only worked in Chile, but also spent his honeymoon there with new wife, Jean, a gracious lady who loved her afternoon teas and entertaining.

Mark loved fine minerals, so he traced with individuals and institutions. Specimens sent to him had to go to his home in Iowa for convenience because of

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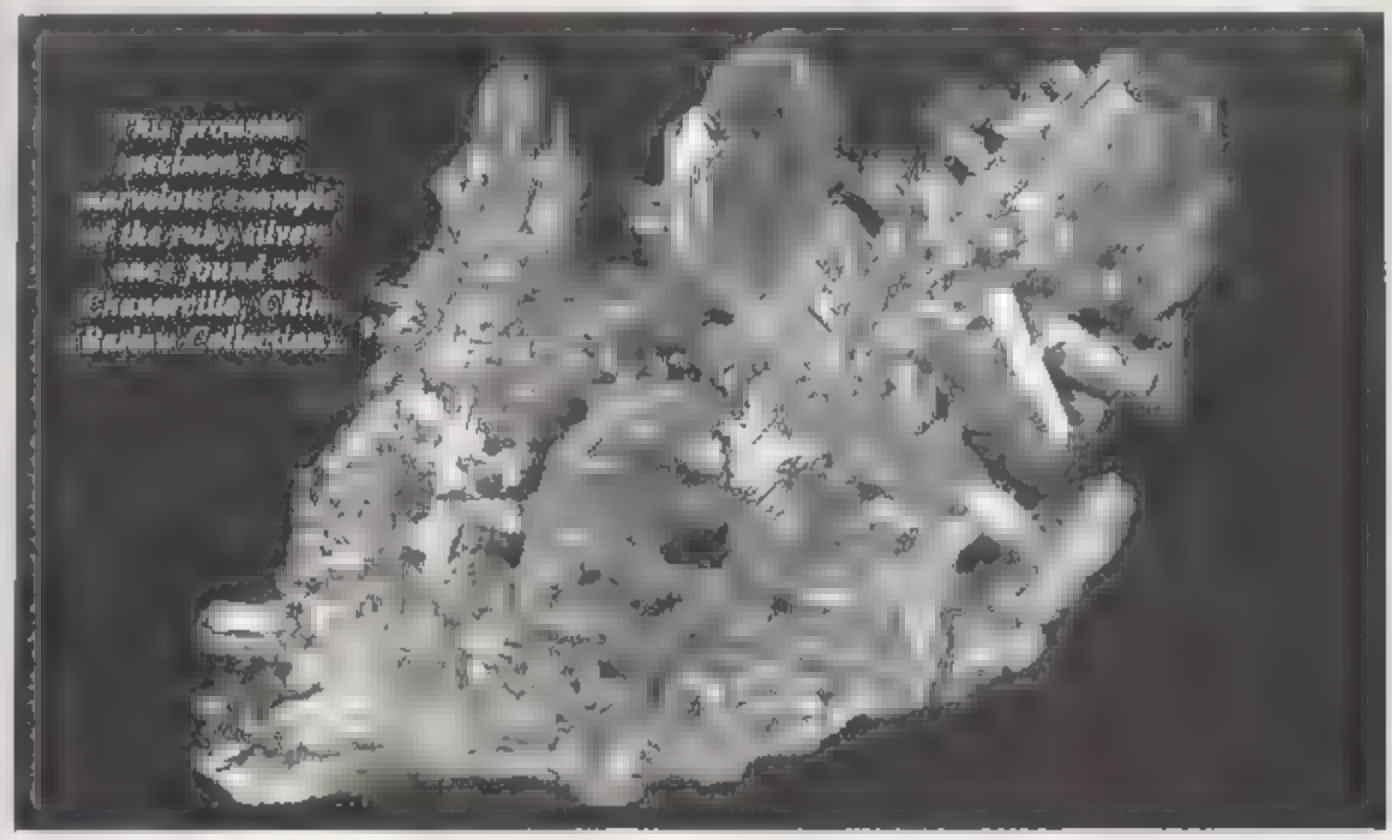
Minerals of the Andes *from page 63*



his travels and foreign assignments, and he did not see much of his collection until after his retirement to Arizona. I was fortunate that Mark and Jean, for whom jeanbandyite is named, moved to Wickenburg upon retiring because I got to appreciate his collection time and time again.

Along with his mineral collecting activities, Mark was also an excellent researcher and writer. He wrote about the mineralogy of Llallagua. After his death, this was published as Special Paper #1 by the Tucson Gem & Mineral Society. Certainly the most important contribution Mark and Jean made to the literature was their translation from the Latin of *De Natura Fossilium*, the second of Georgius Agricola's 16th-century writings. Agricola's first book, *De Re Metallica*, was translated by Herbert Hoover and his wife. Mark and Jean also visited Easter Island, studying and writing about the strange statue heads seen there.

Their home in Llallagua stood overlooking the entrance to the Siglo XX Mine, not only a major source of tin minerals, but a great source for such rare species as vauxite, paravauxite and metavauxite, along with much more common wavellite, a gangue mineral.

The wavellites here are practically a signature species. It occurred so abundantly that almost every specimen from here has a bit—sometimes a lot—of cream to very pale greenish wavellite. Most attractive were plates of tiny, gemmy quartz crystals topped with perfectly spherical balls of wavellite, usually a creamy color.

Of course, there was plenty of cassiterite found here. The bulk of this tin oxide was found ranging from solid banded "wood tin" cassiterite to small, often twinned, and always striated, crystals. Bolivia's finest cassiterites came from another mine at Araca. The Bandy collection has a fine specimen from Araca, a 75-pound chunk of cassiterite completely covered by sharp twinned resinously lustrous, geniculated twins up to 2 inches on an edge. A companion piece about the same size was composed of tiny needle crystals of brown cassiterite. They make quite an impressive display pair.

Mark's collection and papers went to the Natural History Museum of Los Angeles County, where you can enjoy the fruits of his collecting.

On one visit to Wickenburg, Mark told me of an interesting adventure he had at Llallagua. The miners, very unhappy with their working conditions, went on strike. This was not an ordinary strike, it was pretty violent. In this one, the strikers grabbed some of the engineers, including Mark, and held them prisoner in the mine, threatening them with death if their demands were not met. Some of the engineers were harmed before the strike ended, but Mark was so well liked he ended up helping with negotiations, and the strikers released him unharmed.

Certainly, the most famous specimen from Potosi, is not a silver specimen. Rather it is a phosphate mineral, a Bolivia. is a gemmy twinned crystal of phosphophyllite, a remarkable blue-green, 7-inch perfect twin sitting on matrix. The specimen has been photographed again and again and displayed as often, including being displayed several times at Tucson. If you don't see any other Bolivia mineral at the show, be sure to check this one out.

Since mining has been going on here since pre Columbian days, new minerals have been found in the Andes region. When Mark worked in Chuquicamata, he found a few new species, as well as rare species in abundance, like bright blue blades mineral called krohnkite, also spelled kroehnkite. The Bandy collection boasted a superb example of this mineral, which is rare everywhere but in Chile. Krohnkite tends to be found in fibrous masses rather like ulexite, but the Bandy piece is a true free standing crystal. Jeanbandyite, an iron, manganese tin hydrate, on the other hand was collected by Mark at Llallagua and languished in his "what's it" box until after he retired.

Much more recently, one of my favorite specimen collectors, Terry Szenics, was visiting the Tierra Amarilla Mine in Atacama, Chile, when he came across a blades green mineral. He didn't think much of it, but after leaving the site he realized it had some unusual characteristics, so he turned around and went back and gathered what he could from the mine dumps. When he checked with Harvard the green mineral turned out to be new and was named szenicsite. Terry was at the Tucson Gem & Mineral Show when the identification of the new mineral was confirmed. He was thrilled when a phone call informed him that the new mineral had been named after him. I'm sure he was as thrilled as I was when I found out about a new mineral named after me, also while visiting the Tucson Show. Once that mineral is formally announced, I'll tell you all about it!

Of all the mines ever worked in the Andes, the one that has produced the most sought after mineral, gems excluded, is the silver mine at Chanarcillo, Chile. Long since mined out, this mine produced some of the world's most spectacular ruby proustite crystals. Native silver was also found here, but it is the proustites that set every collector's heart racing.

Proustite is one of two "ruby" silvers, the other being pyrargyrite. The Chanarcillo proustites are gemmy enough to be faceted, but the mineral is so soft a fingernail can scratch it. Still, its finest crystals can exceed 4 inches in length, sometimes sitting on a solid mass of the material. Striations are common on the hexagonal crystals, and finely terminated blades are much sought. The mineral is exceedingly light sensitive, darkening on prolonged exposure to light, so few museums or private collections display the specimens. Harvard has a nice display of German and Chilean blades. The crystals are in a dark light box. If you lift the lid, light goes on and you can admire the ruby red blades. So if you do get to see a fine proustite at the Tucson Show, admire it and also admire its owner for sharing a very sensitive and rare specimen with you.

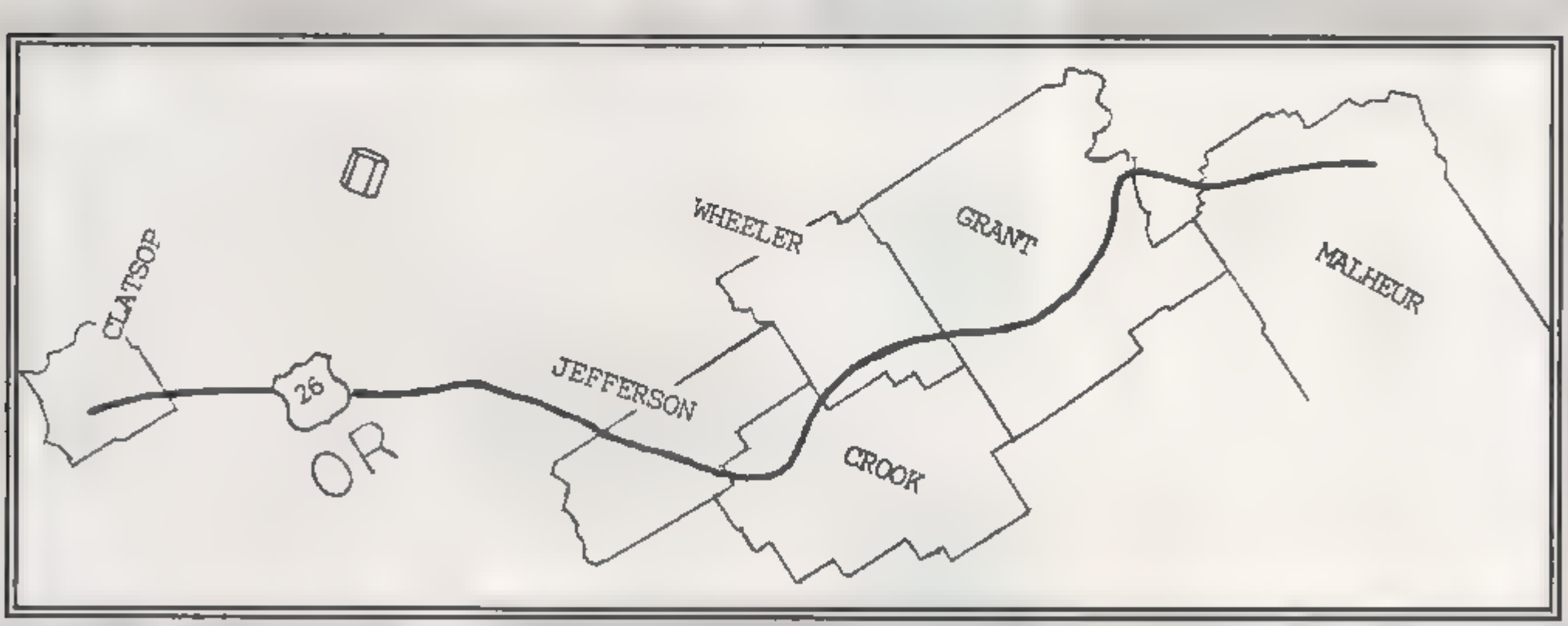
This has been just a glimpse of what you can expect at the Tucson Gem & Mineral Show this year. The range of species goes from simple quartz and calcite to rare szenicsite, gem emeralds, and ametrines superbly mounted and carved by experts. In between is a broad assortment of crystallized sulfides and associated minerals.

The show runs for four days, Feb. 13-16. And don't forget to come to the evening reception on Feb. 12. It's free, but you need to make a reservation by calling (520) 471-0499. I'll be there!

GOLD AND GEM HIGHWAYS

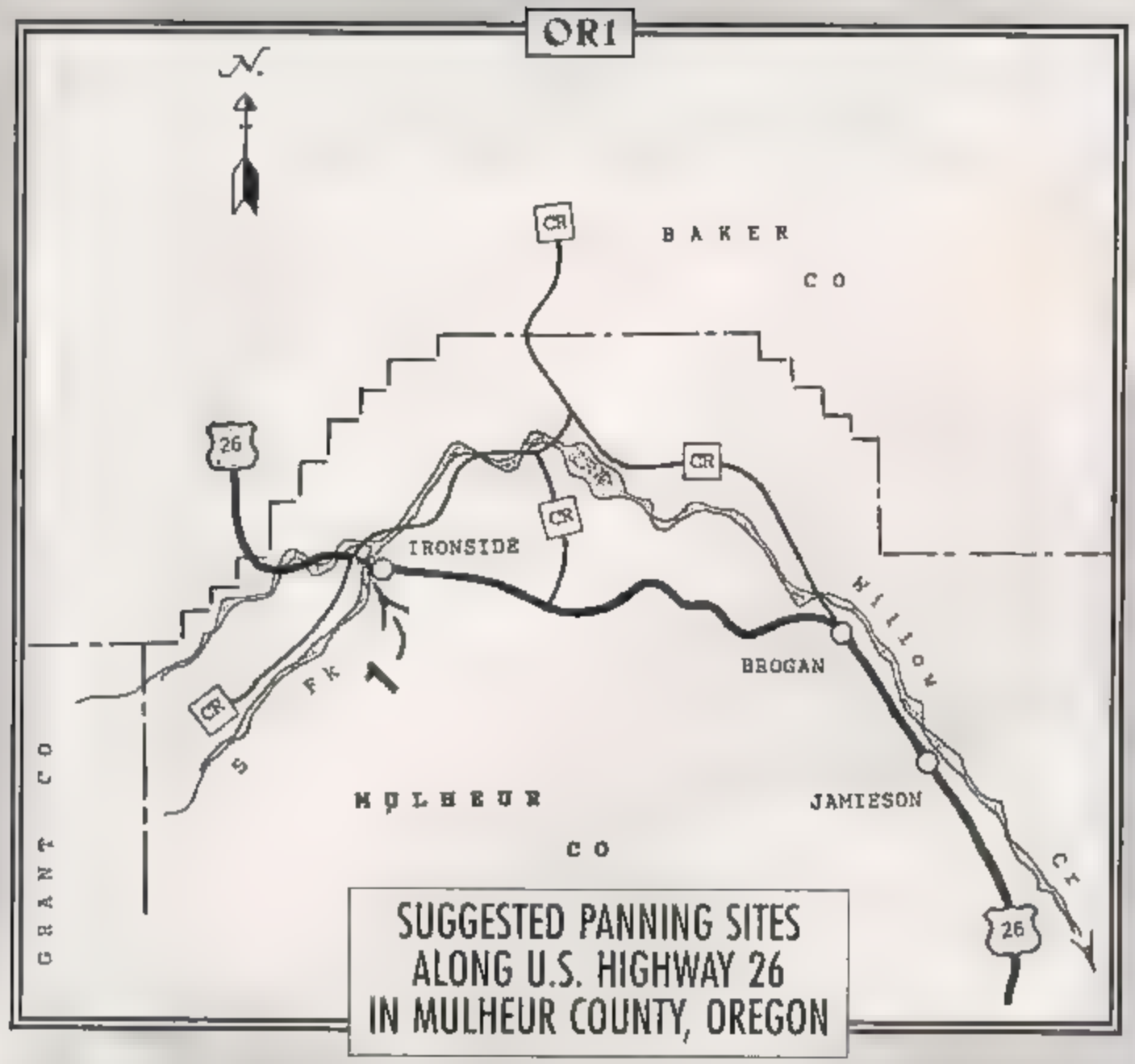
PANNING SITES ALONG U.S. HIGHWAY 26

These Oregon Sites Show Potential

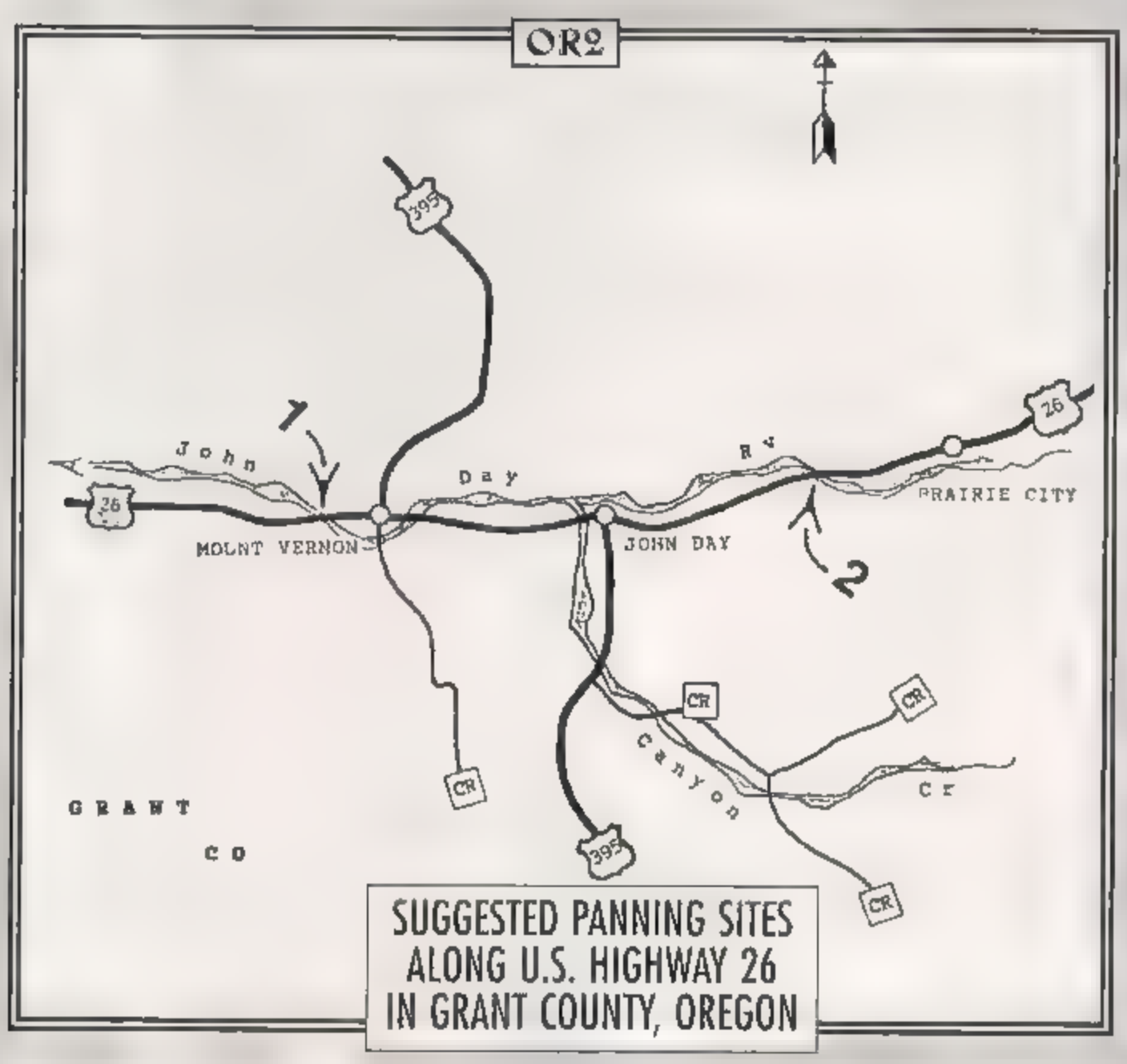


While tracing the routes of some of the known placers along the various rivers and streams contributing to their natural transposition downstream is scarcely all that unique, research along selective highway/stream crossings appears to be much more limited. Accordingly, then, we have recently arranged some of our files on statewide potentials to meas assessable by a number of the more prominent roads and highways.

We've selected U.S. Highway 26 as one of the most prospective in Oregon, with potentials beginning at Site 1 near Ironwood and ending at Site 6 near Jewel. Corresponding vicinity maps indicate the various location details, and the more appreciable finds anticipated through continuing erosion of the known deposits upstream have been listed.



SUGGESTED PANNING SITES
ALONG U.S. HIGHWAY 26
IN MULHEUR COUNTY, OREGON



SUGGESTED PANNING SITES
ALONG U.S. HIGHWAY 26
IN GRANT COUNTY, OREGON

However, since we are both in our 80s, we're relying more on the coordinated-research potentials than on personal field trips. We're leaving it up to the more venturesome to be willing enough to take a chance on the various potentials—perhaps they'll share with us how successful they have been.

It is decidedly more advantageous to operate within prescribed highway rights of way than to attempt to locate and obtain access privileges from sometimes difficult land or mine owners! Highway personnel too are often fussy about the usual safety and environmental standards, being particularly adverse to illegal parking and digging in highway embankments. In lieu of the ongoing tourism influx, however, a smile usually begets a smile, and pan and scoop are scarcely ever contested in court. So good luck, but remember the odds!

LOCATION AND VICINITY FINDS ALONG U.S. HIGHWAY 26 IN OREGON

MALHEUR COUNTY (Map OR1)
Site 1. Crossing on South Fork of Willow Creek, near IRONSIDE. Vicinity finds include agate, chalcedony, jasper, and silicified wood.

GRANT COUNTY (Map OR2)
Site 1. Crossing on John Day River, near MOUNT VERNON. Vicinity finds include chalcedony and gold.
Site 2. Crossing on John Day River, near PRAIRIE CITY. Vicinity finds indicate gold potential.

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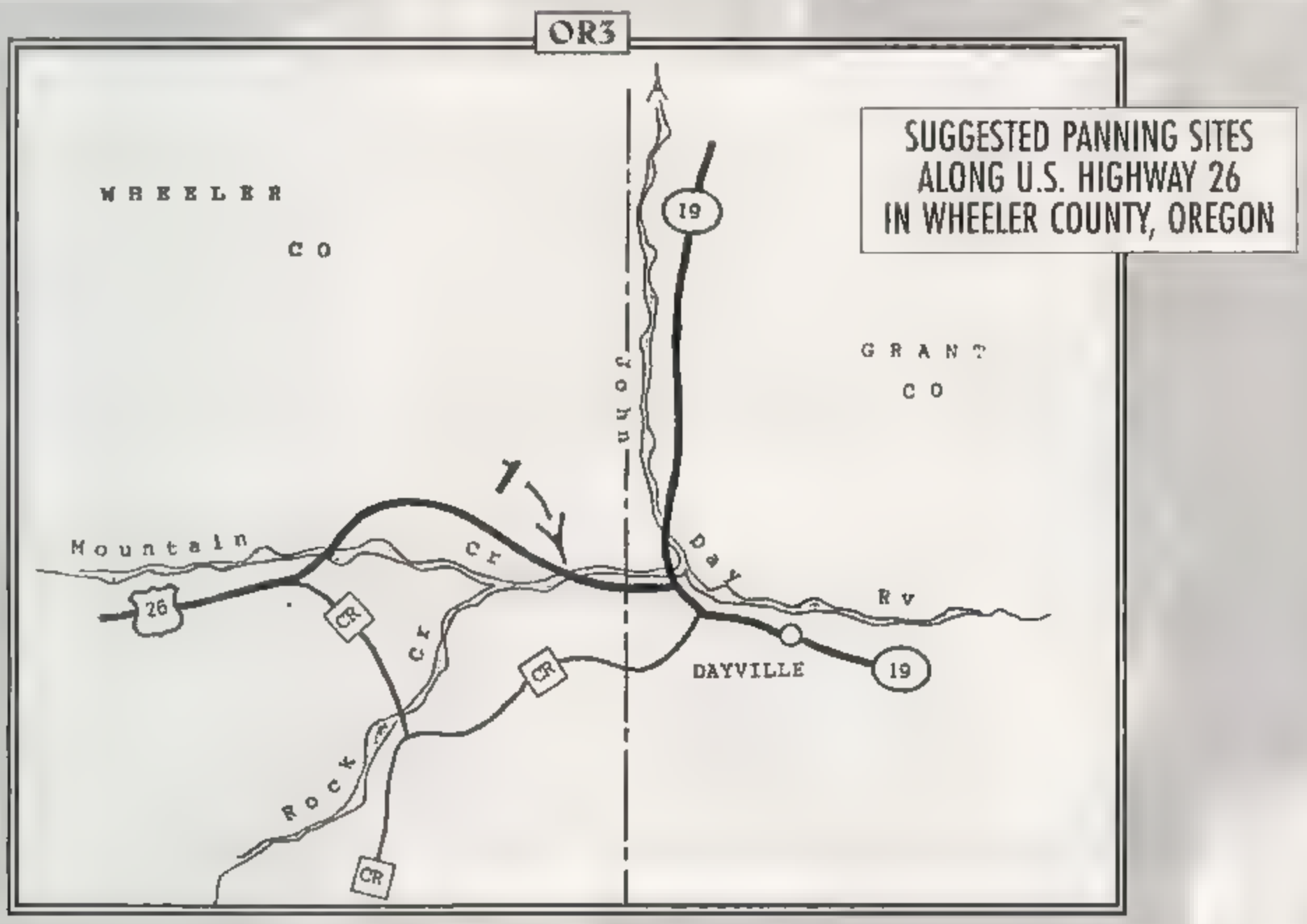
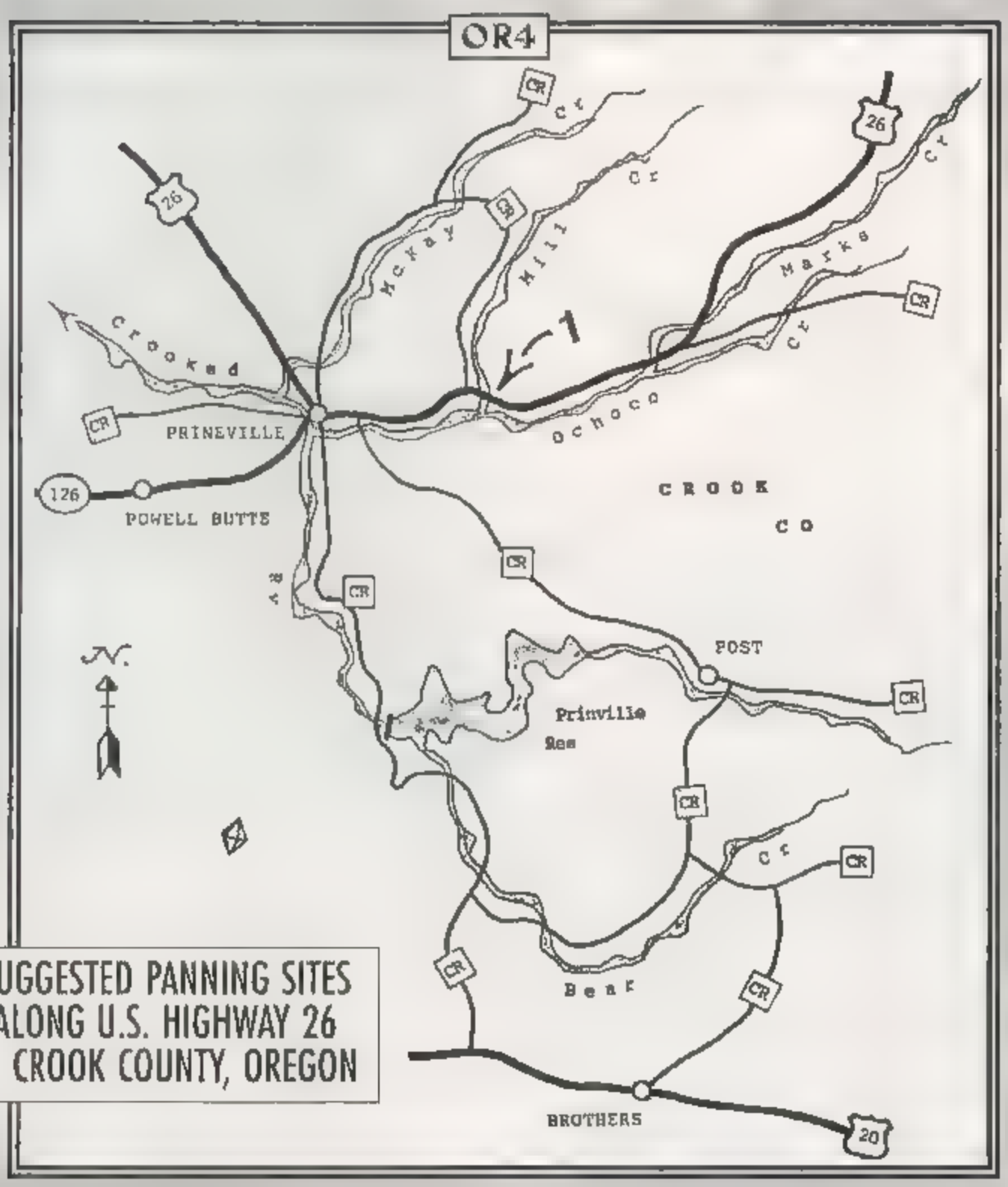
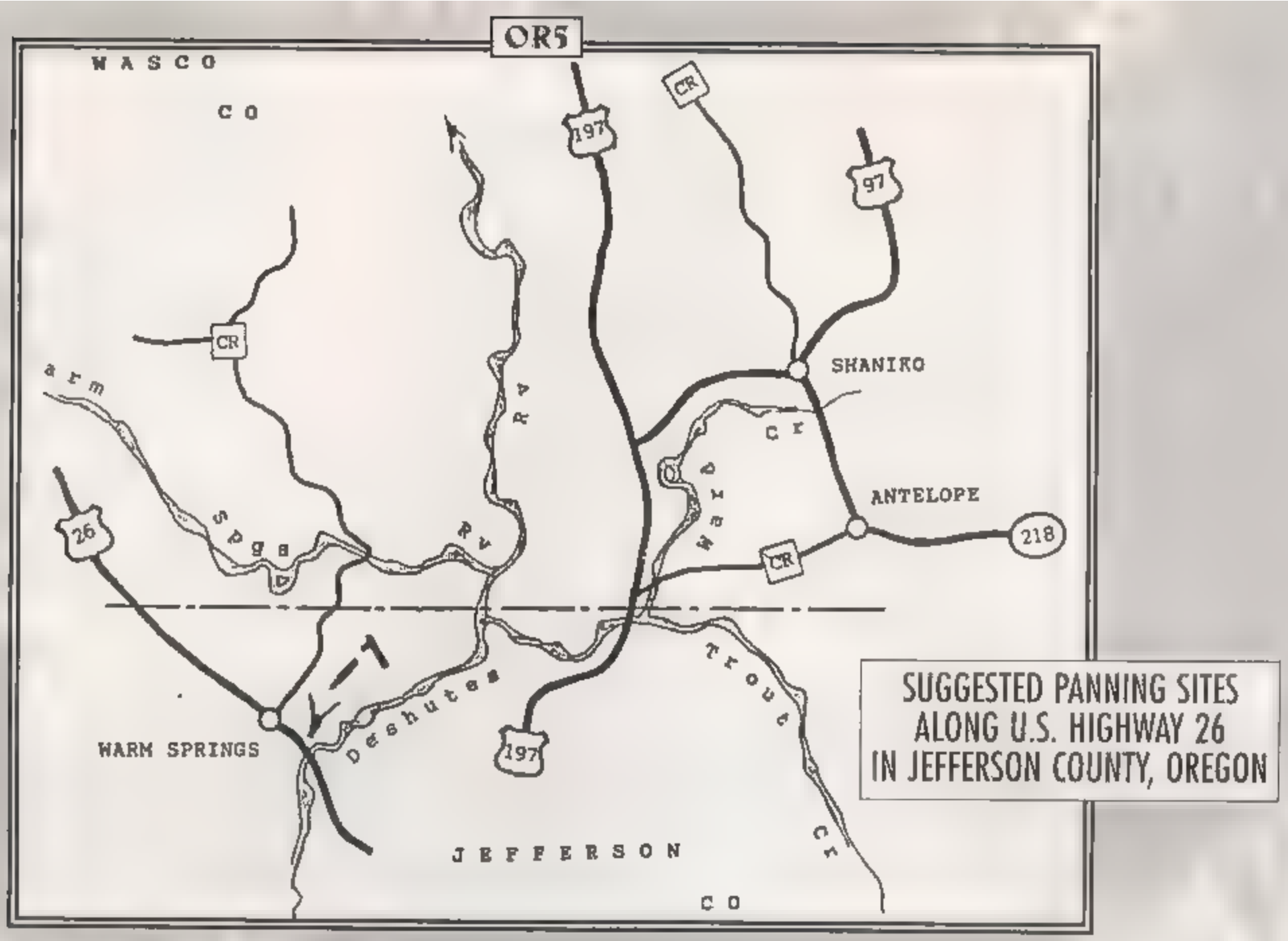




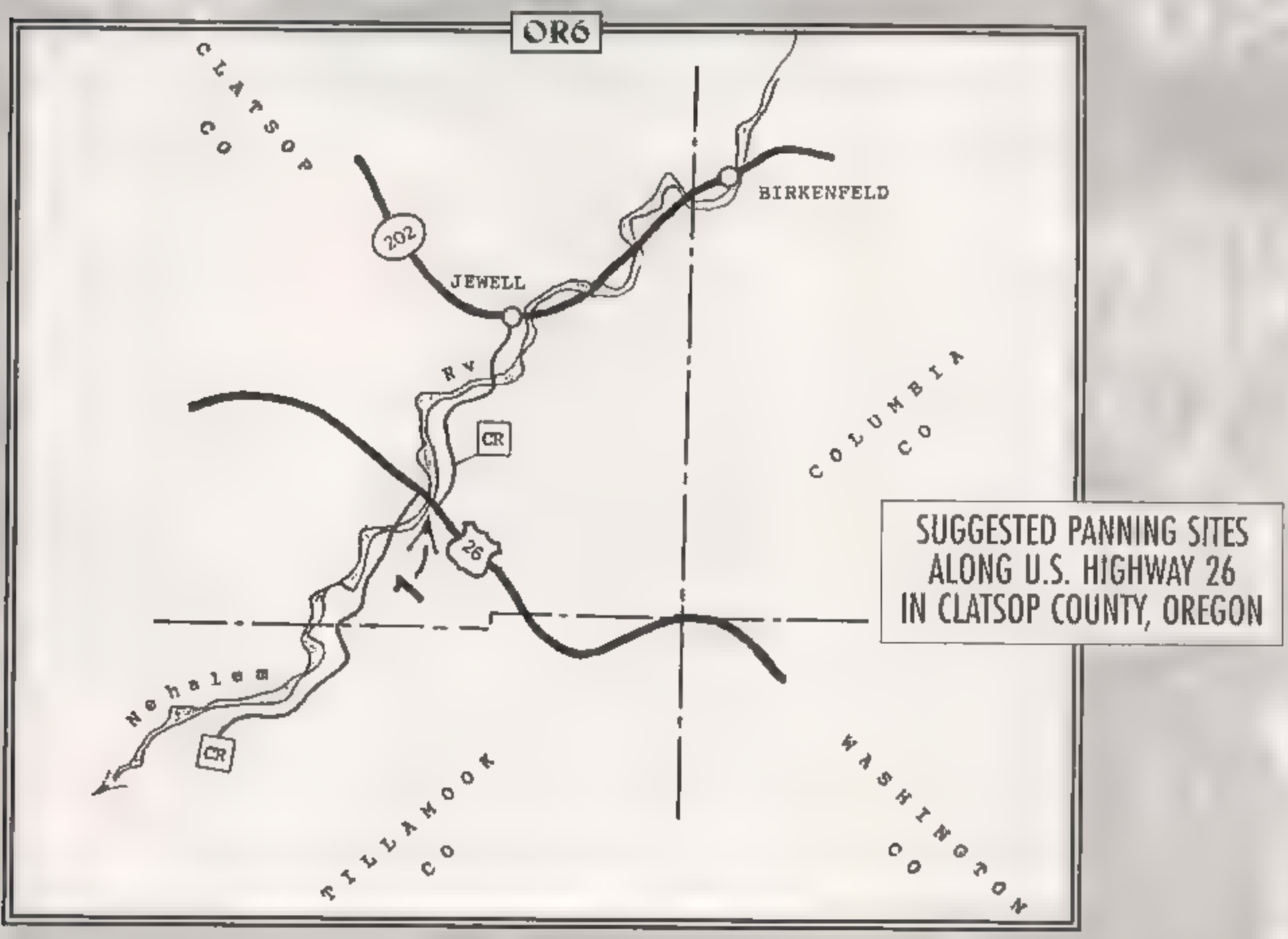
WHEELER COUNTY (Map OR3)
Site 1. Crossing on Mountain Creek, near DAYVILLE Vicinity finds indicate gold potential

CROOK COUNTY (Map OR4)
Site 1. Crossing on Mill Creek, near PRINEVILLE Vicinity finds include agate, chalcedony and opal.



JEFFERSON COUNTY (Map OR5)
Site 1 Crossing on Deschutes River, near WARM SPRINGS. Vicinity finds include agate, chalcedony, jade and jasper

CLATSOP COUNTY (Map OR6)
Site 1 Crossing on Nehalem River, near JEWEL. Vicinity finds include agate, carnelian and jasper



Gemstone Gravel Beds *from page 56*

Every once in a while I had to tear my eyes away from the bar at my feet and look up from my rockhound slouch to get my bearings. I began searching probably a half-mile from my camper. As we all know, it's almost impossible to thoroughly cover an area as huge as this. We're bound to miss a lot whether we like it or not.

I was search ng for that rare stone, a real beauty that would stand out so strongly amongst the millions of ordinary river pebbles before me. If I did see it, I couldn't miss it. If I didn't search carefully, slow my pace way down, and study the rocks as I went, that stone might elude me and I'd never find it. Therefore, a slow, steady pace is requisite.

Chalcedony is here in quantity. Petrified wood, outstanding agatized wood, and agate nodules of various sizes and colors are all here. It just takes a good eye and a bit of careful searching to find them. When I'm searching an area like this, I often wonder just how many beautiful stones are buried under my feet, probably never to be seen by anyone.

As I walked slowly along, I saw numerous water-worn specimens that would gladden the heart of any rockhound, no matter how particular. But I kept searching for that one great stone. I saw agates that were so dense that they looked black even when held to the sun. Some were good and went into my bag; others were very translucent but without any inclusions, so I passed them up. Then I found that stone I was looking for. It's fantastic! It resembles, to me anyway, a smooth lump of scrambled eggs, including the gold and creamy white coloration in the stone. It's as large as the palm of my hand and it doesn't appear to be water-worn at all. Yet it has a very glassy surface that might rival anything that I could polish.

Here and there, I saw many water-worn nodules of chalcedony that were as large as a grapefruit. Some were dark brown with various other shades of tan to gray throughout. I picked up tiny, well-rounded agates that were no larger than my thumb. Moss agate, the kind we think of when that name is mentioned, is here, but a bit harder to find. One of the reasons for this is that the crust on many stones hides what may be inside. Colors from across the spectrum can be found on these bars, but the predominant colors are light gray to chocolate brown. I collected one dark-gray limb section of agatized wood with alternating lighter gray, yellowish, and off-white growth rings. It's the size of a coffee cup with water-worn edges. Much of the material here has been tumbling in the river for who knows how long. That's why we find very few pieces with sharp edges, if any.

I made another rare find while on one of the bars far from the camper. It's magnificent. I couldn't bear altering it in any way, even by cutting or tumbling. It's a rare entity in itself. This is the kind of rock that stands out in high contrast amongst the myriad others on the bars. Although it has a rounded shape, it doesn't appear (contrary to what I just mentioned) to be water worn. The outside crust on one half of the stone is snow-white common opal, with serrated gray lines where the growth rings once were. One side is cleaved off, exposing dark gray to creamy gray straight bands. I put it under my long wave UV light and it fluoresces wonderful blue, cream and black contrasting bands, resembling a zebra's stripes, on one side, and on the cleaved side, brilliant harvest-moon orange and violet colors emerge. Some of the other stones I collected also show some fluorescence under the UV light, especially those moss agates that have a partial coating of opal.

This large specimen of Montana moss agate has numerous dendritic inclusions.

During my weekend stay at this site, the fact that it had rained the night before I arrived worked in my favor. The stones were quite clean to begin with, but the rain brought out the colors, making for easy identification. I picked up one walnut-size moss agate of light, translucent gray with very nice black dendritic inclusions in it. I found another piece that is so dark it appears glossy black. One telltale clue to look for while searching for moss agate is the chalky white common opal crust that often covers many of them. Without fail, they invariably will have some white on the surface, even if they are quite worn from river action. So look for this. You can't miss.

During one of my jaunts in late afternoon, I spotted a plum-size water-worn agate that has marvelous red, yellow, white and gray bands. It resembles, and could easily be taken for, a Fairburn agate. Outstanding!

The petrified wood, which is always water worn here, is of good quality and many pieces are large. Most have light- and dark-brown growth rings, clearly defined despite the wear. I found one that has a creamy off-white color, with contrasting darker growth rings, polished to a high gloss by the forces of nature. Who knows how far this material must have traveled during the centuries in the river?

When you're on the gravel bars, I suggest a good, sturdy pair of shoes, preferably with a bit higher tops than tennis shoes, and a hat or cap to protect the noggin from those dangerous UV sun rays. A good pair of sunglasses will also cut down on the glare. Insect repellent helps to hold off the biting insects. They weren't bad when I was there in August, but they can be a nuisance at times, especially when there's no breeze to blow them away.

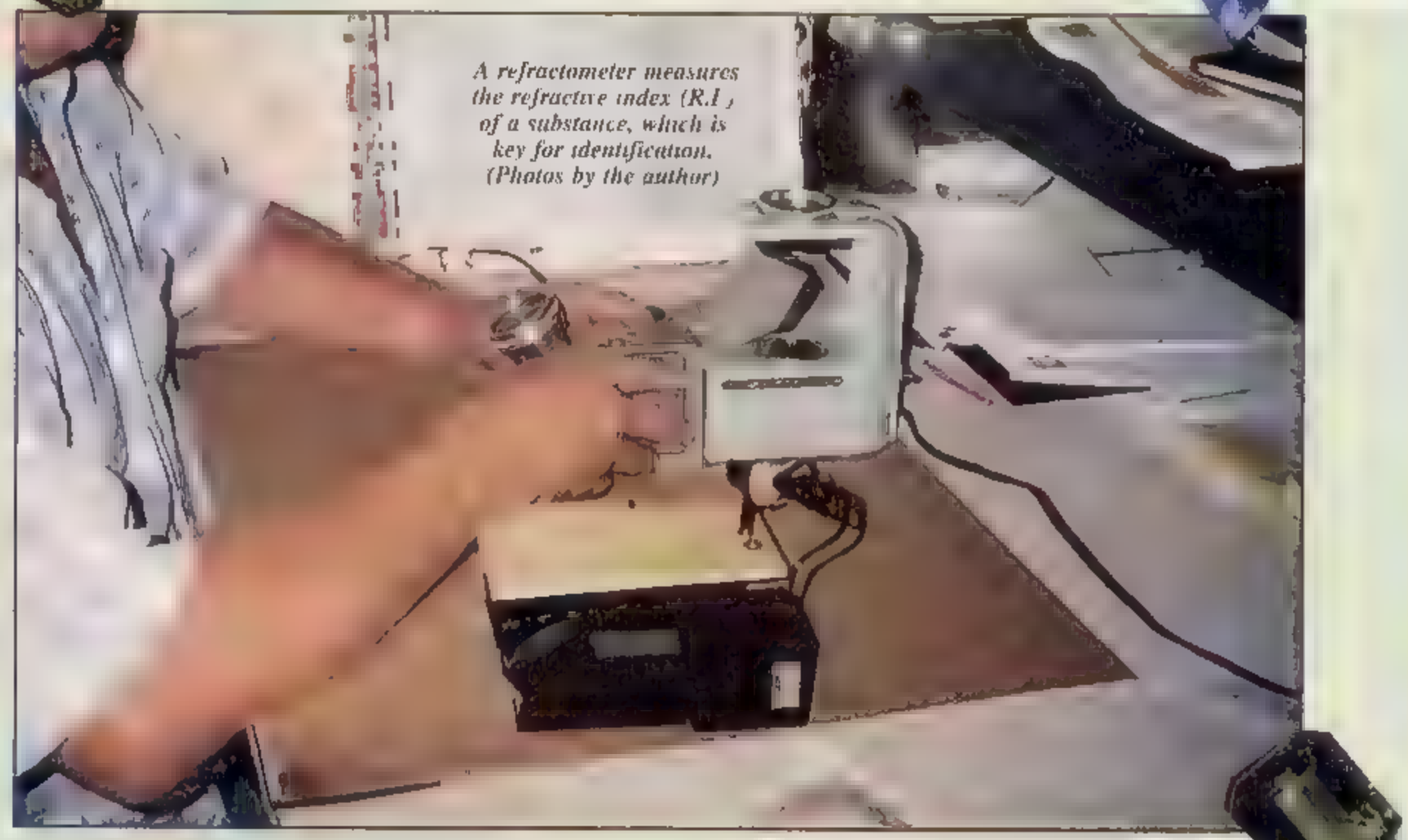
Also, I'd like to point out that you'll be in snake country. As a rule, they'll try to avoid contact with humans, but play it safe and look where you walk and avoid reaching down behind pieces of driftwood or large rocks until you check them out. In all my years of collecting, I have not yet come in contact with a rattler, although there's always a first time.

Crane is a tiny hamlet on state Route 16. Interstate 94 travels east and west to the south of Crane and state Route 16 can be intersected at Glendive. U.S. Highway 2 lies to the north and taking state Route 16 south at Culbertson, Montana, will take you to Crane via Sidney. Once in Crane, take the Seven Sisters Fishing Access Road for about two miles to the river. Remember to take the left road at the "T" for a short way to the turn around at the boat landing and fishing access. The gravel bars are but a stone's throw from the turn around area. The road is solid and should hold heavy vehicles with ease. The gemstones are there, and if we use prudence and good judgment, future generations of rockhounds will also be able to enjoy these bountiful gravel bars. In other words, only reasonable amounts of gemstones should be taken from the river.

By the way, off-road overnight parking is permitted in both North Dakota and Montana. If you are traveling with a self-contained unit like mine, you can save a buck or two, like the man says. Follow the rules of good sportsmanship and don't leave anything but your footprints. It's a good policy. You'll have a great time in Montana. I always do.

GEMOLOGY:

Learning the Craft



A refractometer measures the refractive index (R.I.) of a substance, which is key for identification. (Photos by the author)

Using the Refractometer

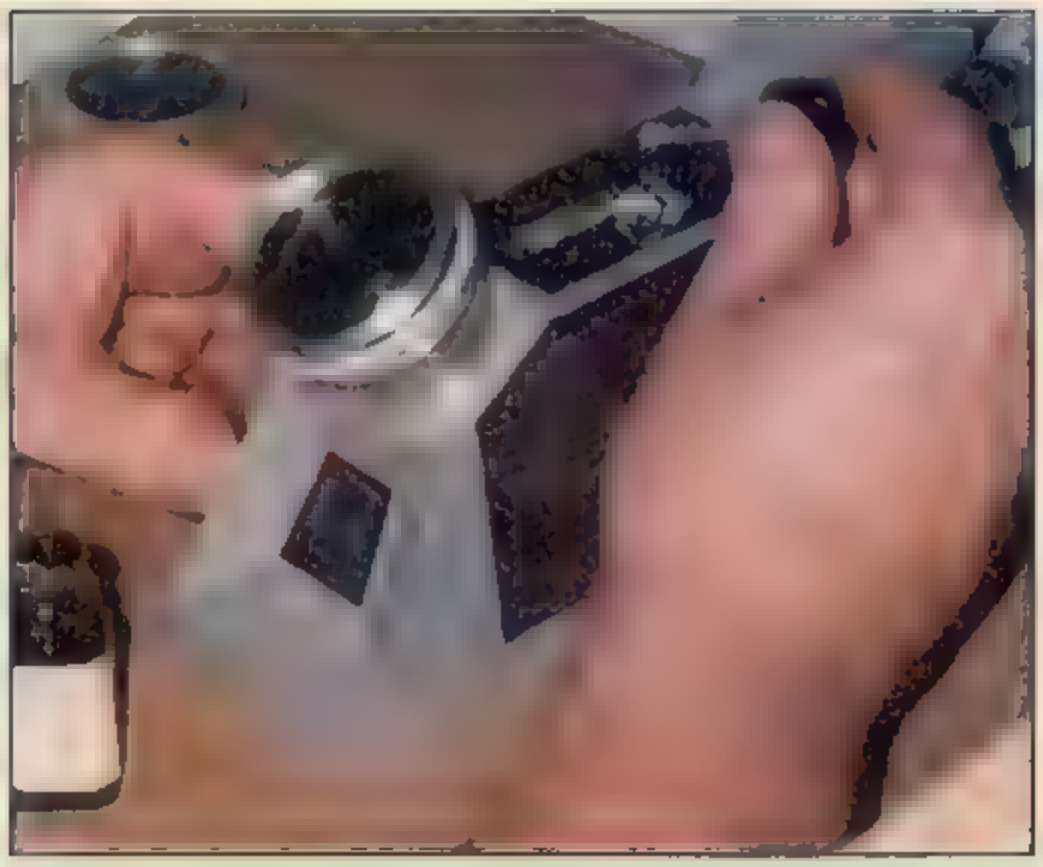
by Douglas S. Le Grand, G.G.

Let's review what we covered in the first article of this series, "Getting Started" (January 2003 *Rock & Gem*, page 48). I began by talking not about fancy, expensive equipment, but about going on field trips and to gem shows and rock and mineral club shows. I also talked about the hours you will spend learning the characteristics of different minerals. As time goes on, it will become apparent why I started off in that direction, but for now you will have to trust me. This is the way I learned, and I feel that the special people who taught me knew what they were talking about. The purpose of going on field trips (rockhounding) is to help you discover rough minerals and see how they look in their natural environment. It helps you appreciate the true rarity and beauty of these gemstones as you learn more and more about them. A side benefit is that you get some exercise and fresh air, and a chance to enjoy the natural beauty that surrounds us.

Becoming a gemologist is different than anything else I have ever done. It is not like working at a local jeweler's, most people who work at these places usually do nothing more than work as a clerk. A gemologist needs to know more than just the price of an item. When you are spending hours reading and studying for your gem identification exam, it is your love and appreciation for gems that will carry you through the tough times.

If field trips and rockhounding are for learning about natural stones and the environment they are found in, then you might be asking, Why go to trade shows and rock club shows? In the beginning, learning to identify gemstones—trying to separate blue topaz from blue sapphire and tanzanite from blue tourmaline, for example—was confusing. I knew what turquoise was, but I didn't understand why one cabochon was selling for $1 and another for $20. Did you know that people actually make synthetic turquoise, peacock stone, and lapis lazuli? I also thought rubies and garnet looked the same, and I didn't even know about red spinel. The reason I recommend going to trade and hobby shows is this: The variety of stones and minerals used in jewelry is mind-boggling and it is easy for newcomers to be overwhelmed. It's best to become aware of the material that is available and sold to hobbyist and professional jewelry makers before you try to identify it.

Rockhound club shows still tend to draw more of the agate and natural mineral crowd. You will hear many different names for the same stone, but these names are describing different colors or physical characteristics. What is that all about? Looking for differences can be confusing if you let the bright lights of advertising mislead you. As a gemologist, you will need to



To take a refractometer reading, place a very small dot of refractometer liquid on a polished surface.

Lightly touch the stone to the spot of liquid, then place the stone on the hemisphere lens of the refractometer.

stay focused. You will learn that each mineral has a unique characteristic. You will also learn that many stones have overlapping optical and physical properties. You won't be fooled if you follow my Five Step Test. The key is to base your decision on evidence accumulated from these five different tests:

1. Refractometer
2. Dichroscope
3. Polariscope (with sphere used for identifying optical characteristics)
4. Specific Gravity Heavy Liquids
5. Spectroscope

These five simple, yet effective tests will help you separate ruby from garnet, blue sapphire from iolite and several main natural stones from synthetics, especially emerald. While these tests won't work in every case, they will help you 80 percent of the time.

Let me repeat this very important point. Do not ever think you can look at a stone and know what it is. It's a fool's game that no one wins. I usually set up booths at gem fairs and rock and mineral shows and offer free gem identification. Over a weekend, I might see as many as 100 stones. I will *never* identify a stone without making these five tests. When a customer asks me to write a certificate, they are asking me to write a legal appraisal, to place a valuation on the stone. I take this seriously! After I test the stone properly, I will sign my name to that document knowing that I have done the best that I can to identify that stone and place the correct market value on the item. My ability to properly identify the stone in question and grade its value is my job, and my reputation is based on my professionalism. When someone tries to outguess me on a stone, I don't allow myself to be caught up in the trap. Always, always use these five simple tests and you will be on your way to being an expert.

Throughout these articles, it will become clear that gem identification is a process of carefully performing these tests, writing down your results, and *then* correctly identifying the stone. It is a process of elimination using scientific instruments to carefully detect the subtle nuances. So do not identify the stone first and then use the test to prove whether you're right or not. If a client brings a purplish-blue stone to you to identify, you don't immediately tell them, "It's a sapphire," and then perform your test. If you're wrong, you will look like you don't understand what you are doing, and you'll ruin your reputation with that person. Your excellent doesn't understand what you are looking at or the test you will be using.

Let's discuss a little bit of theory behind gem identification. I would like to point out at this time that a gemologist performs only nondestructive tests to identify gemstones, while mineralogist labs will pulverize, liquefy and vaporize a mineral to detect its makeup. Could you imagine testing someone's tanzanite in that manner?

Gem identification for us falls into two broad areas of study: optical characteristics and physical characteristics. Optical characteristics—color, refractive index (RI), and optic figure—depend on a stone's molecular and chemical structure and how it reacts to light. Physical characteristics such as hardness, cleavage, and specific gravity are not related to light. You need to fully understand how a gem's properties—RI, pleochroism, hardness, and cleavage—affect a gemstone's appearance. So you use your 10X loupe or microscope or trained eye to look at these characteristics to point you in the right direction. Abraded facets, conchoidal fractures, cleavage planes, gas bubbles, clean demarcation lines—all tell the trained gemologist what he is looking for when he sits down to his instrument table.

USING THE REFRACTOMETER

If I was stranded in the middle of a shopping market in Africa and I only had one tool to use to identify gemstones other than rubies, it would be the refractometer. What is a refractometer and why is it so important? A refractometer measures the RI of a solid substance, which is key for identification. Right now, I would like to make a distinction between reflection and refraction. "There are two simple laws of reflection and they are: 1. The angle of incidence and the angle of reflection are equal. 2. The incident ray, the normal and the reflected ray are all in the same plane. Be sure you understand this." (*Handbook of Gems and Gemology*, by Charles J. Parsons and Edward Soukup, page 39). You have to remember that, in actuality, millions of light rays will be striking the stone's surface from every possible angle, but each will follow the same laws and will be reflected or refracted according to those laws.

The idea is that not all the light that strikes the stone is reflected. Some of the light will be refracted into the stone. The amount of light reflected from the stone depends on the RI of the material, the degree of polish of the surface, and the angle at which it strikes. Light that strikes the surface at a 90-degree angle is not reflected at all but is refracted entirely. For all you math lovers out there the formula is given here:

continued on next page

$$\frac{\text{186,000 miles per second (Speed of light in air)}}{\text{Speed of light in denser material}} = \text{RI of denser material}$$

Or

$$\frac{\text{186,000}}{\text{RI}} = \text{Speed of light in denser material}$$

The R.I. is a measure of how the light is bent, or slows down, as it enters a different medium.

SNELL'S LAW OF REFRACTION:

1. When a ray of light passes from one medium into another, the sine of the angle of incidence bears to the sine of the angle of refraction a definite ratio which depends upon the two media in contact and the nature of the (wavelength) of the light.

2. The incident ray, the normal at the point of incidence, and the refracted ray are all in the same plane. The ratio between the sine of the angle of incidence and the sine of the refraction is the R.I. Therefore, the equation for the actual use is:

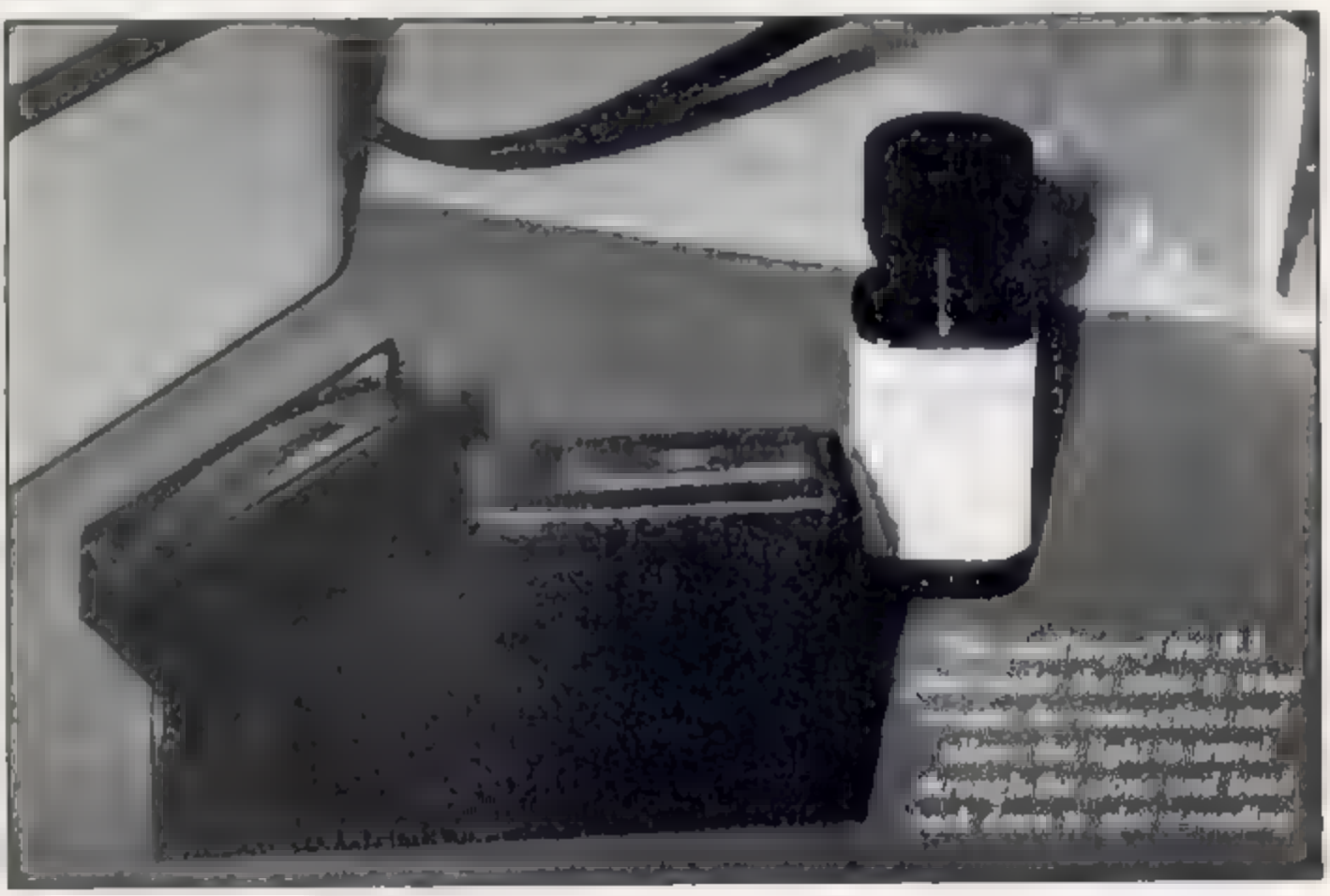
$$\frac{\textit{Sine angle of incidence}}{\textit{Refractive index}} = \textit{Sine angle of refraction}$$

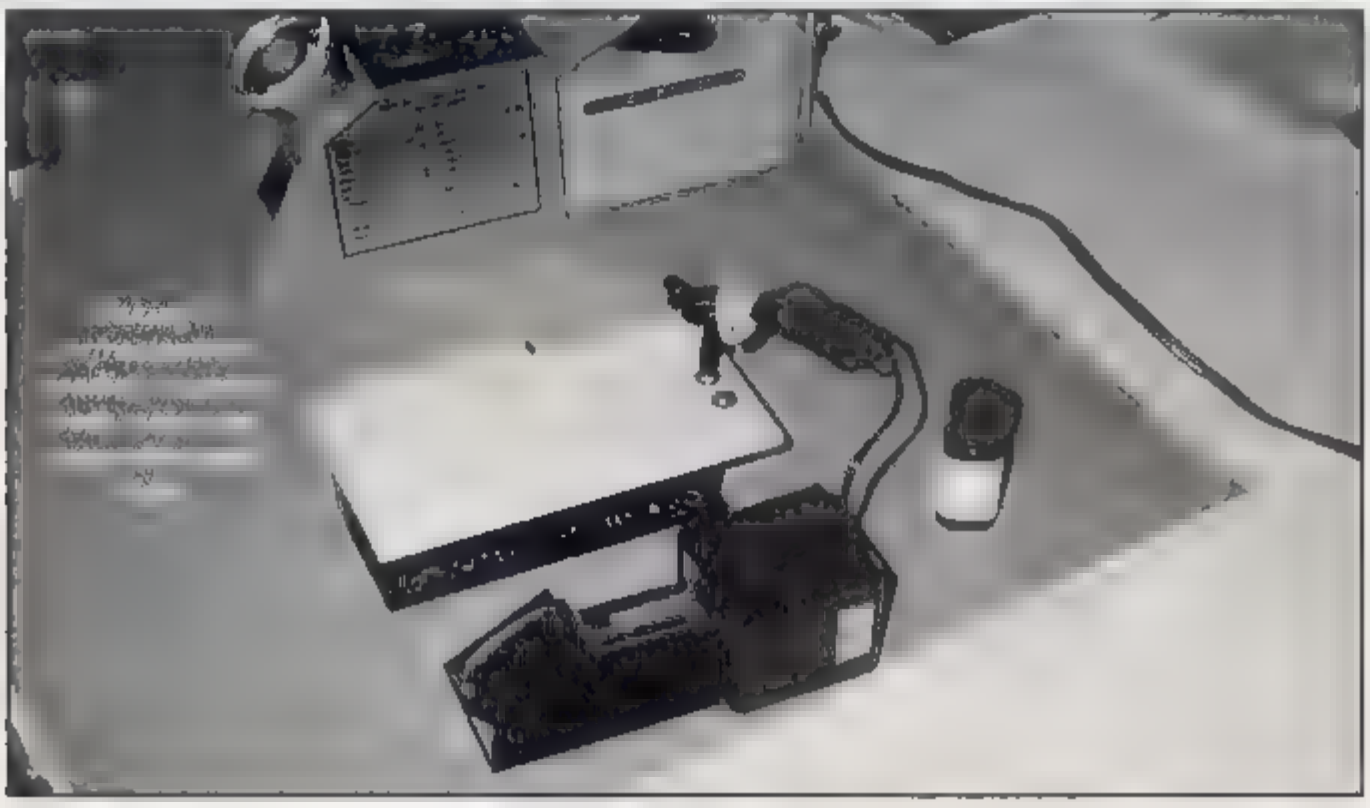
This equation is usually abbreviated to $\frac{Sin\ i.}{RI}$

For example, looking at a glass of water with a straw in it can show this. If you look at it from different angles, you will notice the straw appears not to go straight into the glass but to bend at the water level. This bending is the effect of light as it changes direction upon entering a different substance. The straw is not bent, obviously, but the appearance of it tells us the light has changed speed as it enters the water. The same thing happens inside a gemstone. Each mineral has a unique set of these optical characteristics that we use to identify them. The particular tool we use to identify these optical characteristics is the refractometer.

I like to begin my formal testing with the refractometer. I have already looked at the stone, to see if it is single- or double-refractive. One way is to see if the stone changes color as I rotate it. If it changes color, I have to determine whether it is because of color zoning or because of pleochroism. Just because a stone doesn't change colors is no indication that the stone isn't double-refractive. A simple test of single- or double refractive material is to look through the stone at a fixed light or flashlight. If you see one bulb through the stone, it is most likely a single refractive stone. If you see a double image, it is most likely a double-refractive stone. The farther apart the images, the higher the R.I.

Next, I note its level of transparency, whether it has a phenomenon (cat's eye, star, etc.), adularescence, or color banding, and whether it is the right color for what I am





testing it for I am also looking at the polish of the stone how it is cut, whether it displays a high level of dispersion, and whether the dispersion is the right color All these clues help steer me into the direction of the suspected stone

The refractometer has five main parts

1 The hemisphere, a half disk normally made of high refractive glass to set the stone on
2 A scale, a curved piece of glass or plastic with numbers corresponding to the RI recorded on it
3 A viewing lens that you look through
4 A removable magnifier for enlarging the scale
5 A light portal in the back, through which to shine the light source

To take a refractometer reading you will be using both white and monochromatic light The white light needs to be intense, but diffused, and able to fit directly behind the opening All RIs are listed for gem materials based on yellow light with a wavelength of 589 nanometers; this is the wavelength that refractometers are calibrated at You will also want to keep outside light sources down to a minimum Most refractometers have a cover, and work best if you close it when taking readings The light enters through the back of the refractometer and travels upward toward the hemisphere After passing through the hemisphere and striking the gem, some light reflects downward, passing through the other side of the hemisphere and the scale, giving you a reading

When a person is testing a cabochon-cut stone, the only way to test the RI is to leave the magnifier and filter off and take a spot test A spot test is tricky, but something you have to learn. First, remove the magnifier lens. If you leave it in place, you won't be able to get a spot reading The trick is to take your time, put a very small dot of liquid on a polished surface, and lightly touch the stone to the liquid then place the stone on the hemisphere lens By moving your head back and forth and up and down, you will see a spot thence the term spot test) Once you see the dot, it will go from black to white When the dot is half dark and half white, look at the number corresponding to that midpoint and that is your spot reading

Testing the RI on a faceted stone is very similar, remember, the stone girdle is to have a nice, high polish to give an accurate reading Using a smooth, flat surface for your test surface, place a very small spot of RI fluid on a polished surface and touch the stone's flat surface to it Now pick up the stone and gently place it on the hemisphere surface You will notice the underside of the stone will puddle with the RI fluid This puddling is what creates the connection and allows the light to travel through the stone and bend back down, giving you the reading Usually, the table is a good place to start with your readings It is simple, stable and will give you a good reading

Now the hard part finding the reading on the scale inside the refractometer By moving your eyes or head up and down, you will see light reflecting on a scale Your head should be about 12 inches from the refractometer If you suspect a doubly refractive (DR) stone you can leave the filter in place, this will help later on when you try to determine how much DR you have present.

This is the end of your first lesson on using the gem lab equipment The only way to really become good at gem identifying is to practice This is only the first tool you will be using in following articles I will introduce you to the other tools that are used and the correct methods of using them

LAPIDARY LORE and MORE

by June Culp Zeitner

Preserving Access

One of the reasons lapidary grew so rapidly in America was the abundance of excellent materials and open collecting areas. Many of our classic sites are gone forever. A few are only accessible now and then if you know the right people and some hold hope of a similar site in the future or that a closed quarry will reopen or a branch of government will relent.

One remarkable area, known for almost two centuries and now almost extinct but with some slight hopes is in one of all places, Florida. The agatized coral geodes of Tampa Bay, really Hillsborough Bay, first recorded in 1825, are the world's ugliest rocks when found and the second strangest geodes when opened.

The geode deposit is in the Tampa Formation of the Miocene, a deep limestone formation. When people were first curious about the odd stones, they thought the numerous rocks were banished by saints from Spain or maybe France or Italy. The little peninsula was named B Bast Point. When I first went there in 1950, I was surprised to meet fellow geode diggers who still argued that the deposit was not native to Florida. When I asked the reason, a standard reply was, "I heard agate can't form in salt water."

A rockhound friend, Willard Olsen of New Port Richey, first took Albert and me to the beach at a Tampa city park. The park was run down, dirty and unsanitary, and the rocks we saw people digging looked as disgusting as the occasional broken bottle, tasty can or other trash they pulled from the sand and muck. People had their own ways of digging, some used spades, while others used iron bars or steel rods to probe in the mud until they felt something solid. Then they would reach into the mud and grab whatever it was. There were brooms, brushes and spray bottles of water to help examine the items pulled up. Many of the diggers had waded out in the bay up to their knees when the tide was low. As you can guess, the proper wear for this activity was clothing that offered the most protection from the polluted water and muck.

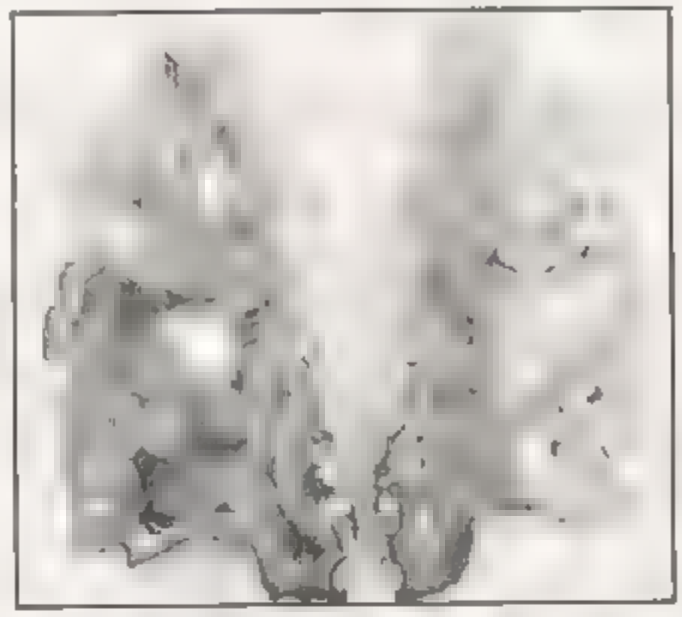
I was about to give up, but Willard told Albert he was getting some real beauties. "Beauty? Ugh!" Did I mention the air smelled like rotten eggs, too? So, Albert wouldn't give up until Willard suggested we accompany him home to view his collection. Of course I had seen him black-and-white pictures in one of the early mineral magazines, but I was truly astonished when I saw Willard's magnificent collection. Talk about gorgeous color, graceful shapes, smooth bubbly textures, shimmering glassy crystals, statuesque creations of nature—it was all there! To add to this, there were agatized shells of many species and, here and there, even an agatized boring clam. Willard picked up a transparent chalcedony finger of coral and we watched primitive water roll back and forth with each motion. I told Albert, "Let's go back while it's still light."

The geodes have been found both north and south of the city, a distance of some 60 miles. The park is long gone. Private homes have retaining walls. No digging allowed! A large portion of the shoreline follows MacDill Air Force Base. No digging allowed! Choice specimens were found in abundance when Davis Island, a man made island, was built. The island is now covered with fine homes, big trees in green lawns and lots of concrete. No digging allowed!

The geodes are gray white on the outside. The next layer is white. Coral polyps, tiny barnacles, and little, lustrous broken shells are seen on the exterior. The geodes are two or three times longer than they are wide. Few of them resemble a sphere or orb in any way. The average size is from 3 to 5 inches. Those over 6 inches are real keepers. When sawed open, the geodes reveal their secrets. Botryoidal chalcedony ranges in orange, gold, yellow, tangerine, ochre, carnelian, blue gray, azure, cobalt, sapphire, navy blue and jet black. A favorite is a lovely Wedgwood blue with deep black. Often there are several color combinations in one geode, some marked with graceful accents of white. I treasure those with sparkling druzy crystals over rare and subtle colors. A spectacular geode resembles an eagle at rest with a translucent carnelian shell and blue and black botryoidal pockets, polished to a soft glow by nature. I have seen a few dendrites, some well defined banding and even iris. The geodes fluoresce green or white.

Outstanding displays of the coral geodes won several lapidary trophies at national and regional shows. Cut and polished geodes that used to sell for a few dollars now sell for $100 or more.

Broken or carefully preformed geodes are ideal for tumbling. The hard, irregularly shaped chalcedony takes a beautiful polish. It's fun to follow the progress during tumbling as the colors and patterns change according to the amount of material removed. Dr. O.C. Mehl of Tampa discovered in the early 1950s how to make exquisite original jewelry from se-



lect pieces of agatized coral. We had our first big batch of preformed coral custom tumbled by Herb Walters of Craftstones. I made and sold lots of coral jewelry, and gave pieces to Boy and Girl Scouts. I still have a handsome black and Wedgwood blue botryoidal pendant and a matching ring set in silver.

Albert and I returned to Florida many times. The areas I knew are closed, but I can never forget the sight of 50 or more people at the Ballast Point beach happily digging in the mud or standing waist deep in the bay, nor the great excitement when someone gave a whoop of joy. Is it all gone forever? Probably. The best and most important of these discoveries can no, be repeated, but the rosy side is that much of the state is underlain with silicified fossil, cherty boulders, and cryptocrystaline quartz nodules. Lots of this land is permanently covered by civilization, but if there is an excavation for a new building or home or a big road project, there is always a chance of finding a treasure.

How can we keep so many field sites from being lost? Clubs are always saving money for one good cause or another. What better use of this money is there than helping to ensure field trips for the future? If clubs know of a productive area or an abandoned mine for sale, they might get other clubs to help buy it. The nearest club could manage it, but other clubs would be welcome.

This is not a new idea, and it does raise questions, but it is certainly feasible. Think of how many things we have accomplished already. Also, we can work harder with quarry owners. We should also participate in meetings, plans and protests when the Forest Service or Bureau of Land Management threatens a field trip site. Land access will never be what it was in the 1940s and '50s, but we have to make every effort to save what we can.

Collecting at the Fat Jack Mine

Great Opportunities North of Phoenix

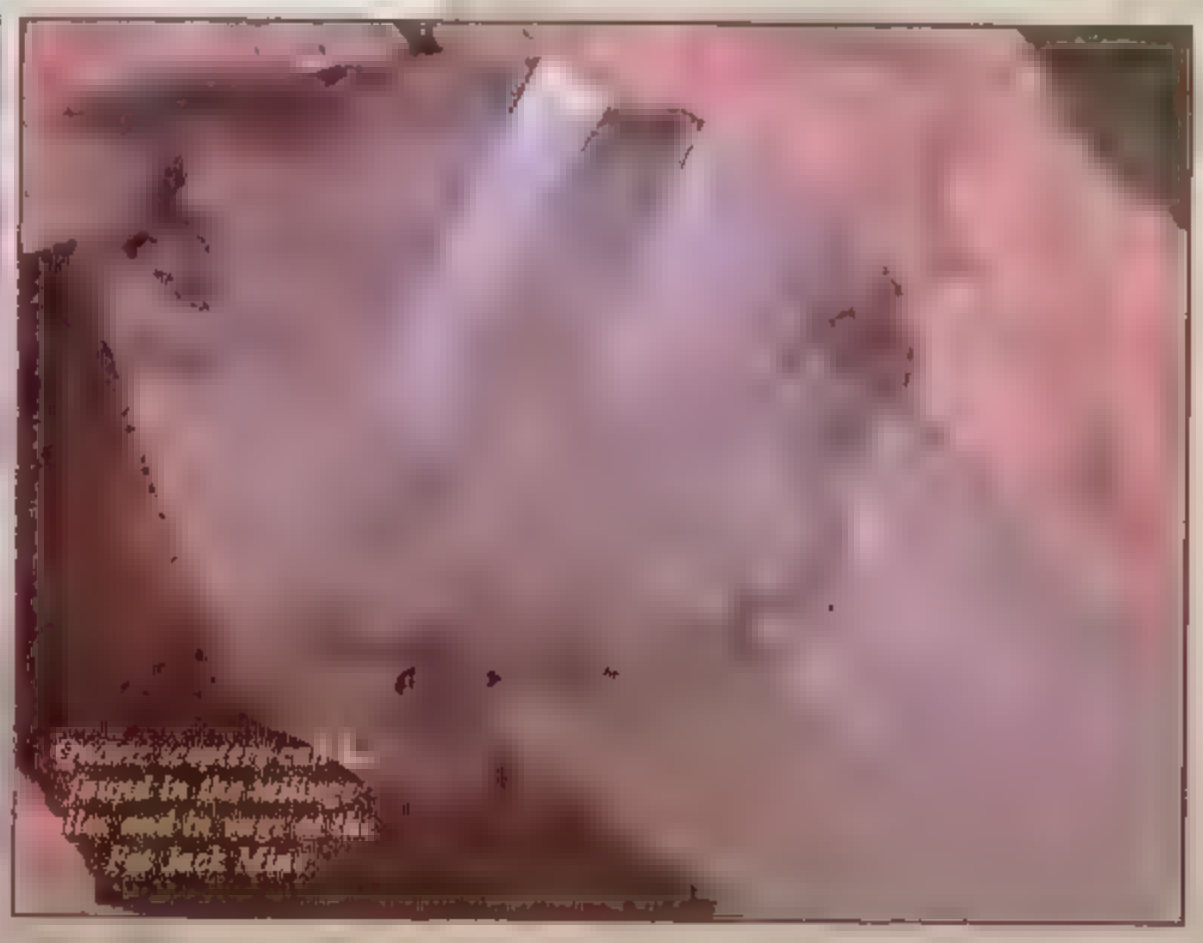
by Steve Decker

Do you remember waking up on the day after your birthday and rushing outside to make sure your new bicycle was not just a dream? As I sit here admiring my newly collected amethyst scepter crystals and feeling my old muscles ache, I do believe the Arizona Mining & Mineral Foundation's Fat Jack Mine adventure was for real.

The Arizona Mineral & Mining Museum Foundation is an organization formed to support the Arizona Mining and Mineral Museum (1502 W. Washington) in Phoenix, Arizona. We raise funds by selling minerals at the Museum Family Day in October, and at the Flagg Gem & Mineral Show at Mesa Community College in early January (see Show Dates in this issue). These funds are used to acquire specimens to display at the museum and to support the museum's projects. It is a pretty special club, with a worthy mission. We have a very dedicated and knowledgeable membership, many of whom are noted educators, authors, and professional geologists. We are all eager to share our enthusiasm for minerals and collecting with anyone who will hold still long enough.

The Fat Jack Mine lies north of Phoenix near Crown King, in the Bradshaw Mountains of Yavapai County. The area was widely explored by prospectors in the late 1800s, and many of the mines and prospects that they located are still producing interesting

A simple test confirmed this fibrous, green mineral find as malachite (Photos by the author)



specimens for collectors. Staurolite and molybdenite crystals are found near Cleator. Nicely terminated schorl tourmaline crystals are weathered out of the granite stocks near the Algonquin Trail head and lie in the pine needles, waiting for you to hike by and pick them up. At the end of the rough road to the Oro Belle Mine you may find epidote, magnetite, and garnet crystals in the metamorphic schist. All of these treasures are found within a couple hours' drive of the city in the cool mountain air on the way to, or just beyond, the Fat Jack Mine.

Fat Jack Campbell claimed the mine more than 100 years ago for gold and silver. The quartz crystals that we treasure today were just a nuisance to the original miners. They didn't want to waste precious space in the burro's saddlebags carrying pretty rocks! They wanted pay dirt! Besides, those glassy crystals cut their fingers as they dug out the mud that carried the precious metals, so they would just break up the pockets and cast the crystals away in the dumps. As we were to see, some of the best amethyst scepters are still to be found on the dumps where old Fat Jack tossed them.

Our trip was originally planned for last June, but the drought in Arizona brought high fire danger and closed the Prescott National Forest to recreational use. We rescheduled for Saturday, Sept. 21, and I hit the highway before daylight to make our 8 a.m. rendezvous. When I arrived at 7:46 a.m., I found some Foundation members already waiting!

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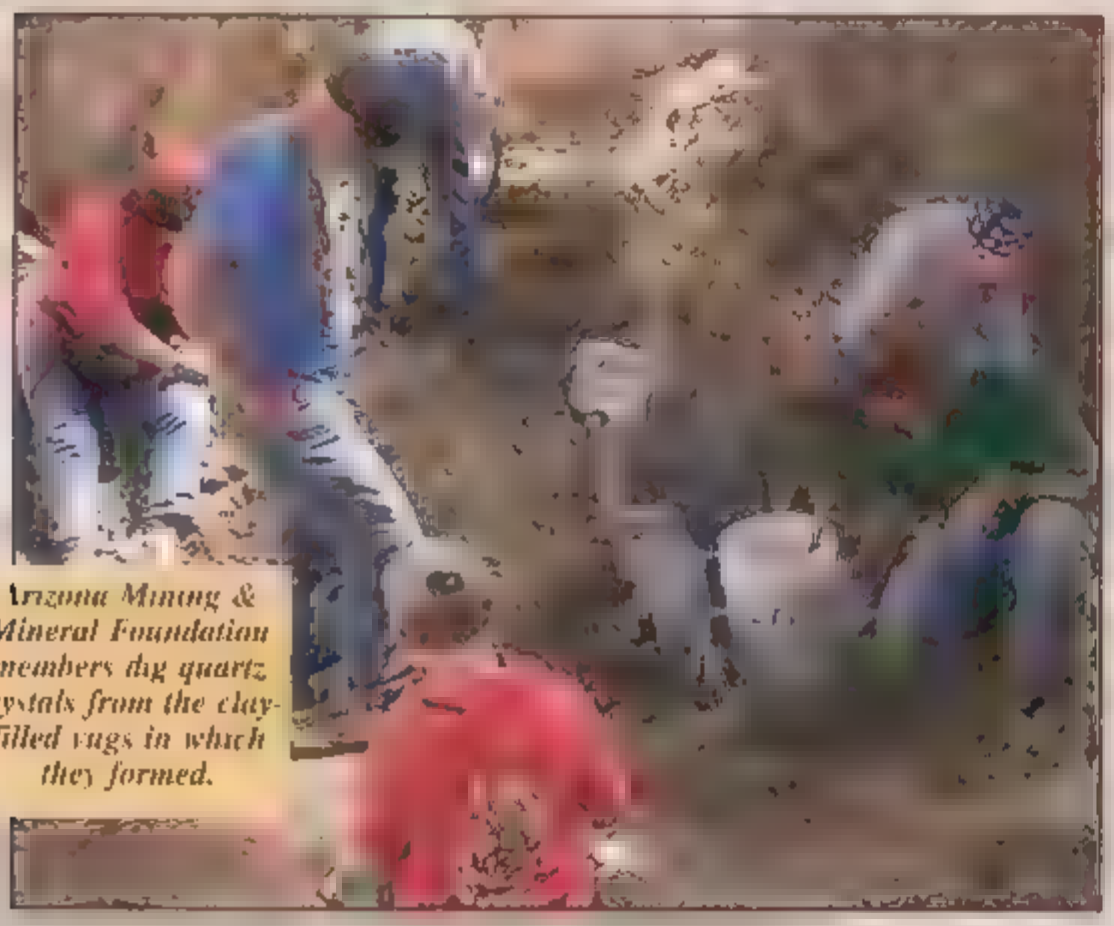
Tiny, yellow, tabular stolzite crystals congregate on a quartz crystal cluster



Arizona Mining & Mineral Foundation members dig quartz crystals from the clay-filled vugs in which they formed.

Collecting at the Fat Jack Mine *from page 89*

Mine owner Gary Spraggins and his dog, Buster, met us amid some good natured grumbling regarding the early hour. After chatting a bit, most everyone loaded up four wheel drive vehicles and started off to the mine, leaving Dana Slaughter and me to wait for stragglers. While we waited, we explored the miserable roads in the vicinity and determined they were way too rugged for my little four wheel drive Toyota van. We also realized we didn't know exactly which road to take to the mine.

When Tom Robertson and his son TJ pulled in, they found me inspecting the damage from a big rock that had jumped out in front of the van. It didn't seem too bad, so Dana and I loaded our tools and lunch into Tom's truck and we all headed for the mine. Though it is only a mile or so from the main road to the collecting area, there are plenty of opportunities to make a wrong turn! Eventually we found our way to the parking area near the mine, signed the liability waiver, and paid the entrance fee. Gary charges $20 per person for most groups to collect at the Fat Jack, but for this Foundation sponsored trip, our members paid only $5 each. This is just one of the many benefits of Foundation membership!

As we hiked up the hill to the mine, we noticed piles of tailings on each side of the road. Gary had placed this material with his backhoe to provide plenty of collecting opportunities for his guests. There had been a rainstorm a couple of weeks earlier, and that sweet water had exposed many little crystals on the surface of the tailings piles. As we scraped through the loose earth, more crystals appeared at our fingertips. I kept hearing exclamations like 'Oh, yea!' and 'Look at this!'" Soon everyone was digging and ah-ing.

Young TJ was a hoot, showing every one his finds and offering to share with anyone who showed an interest. We kept telling him his generosity was appreciated, but he should keep his specimens to show his friends back in the Valley!

I got on my hands and knees and looked closely in the little washes the rain had made. Following these small water courses, I found low places where the quartz crystals had collected. Using this strategy, I found my first amethyst scepter. It's a real beauty, about inch in diameter and inch long. Looking into a termination face, I saw a ghostly image of a much older quartz crystal. This old crystal, or 'phantom' as they are called, was a relic of a time before the amethyst was deposited on top of it, like sugar coating on a candy apple.

Dana found a cool little reddish brown horned toad with turquoise markings on his back. He called for his wife, Brenda, to come see, as she really enjoys wild creatures. The fact that she married a Foundation member is proof enough of that! The little fellow made himself at home on her sweater, looking like a designer brooch until he saw a little bug walking by and got ready to eat it up!

We had a quorum of the Foundation's Board of Directors digging there in the pit, so we quickly nominated the little lizard for a lifetime membership. If he makes it to the meetings, I expect he'll be a board member this time next year.

I walked up to the main area of the mine to see what was going on with the rest of our group. The old shaft from the gold-mining days was visible as a rubble filled gray area in the country rock wall, held back by pine log shoring that Gary had installed. The bottom of the pit was full of water from the recent rains. Gary was busy opening up a hole for those folks who wanted to dig the crystals out of the clay filled vugs where they were formed, rather than gleaning them from the tailing piles as we had been doing.

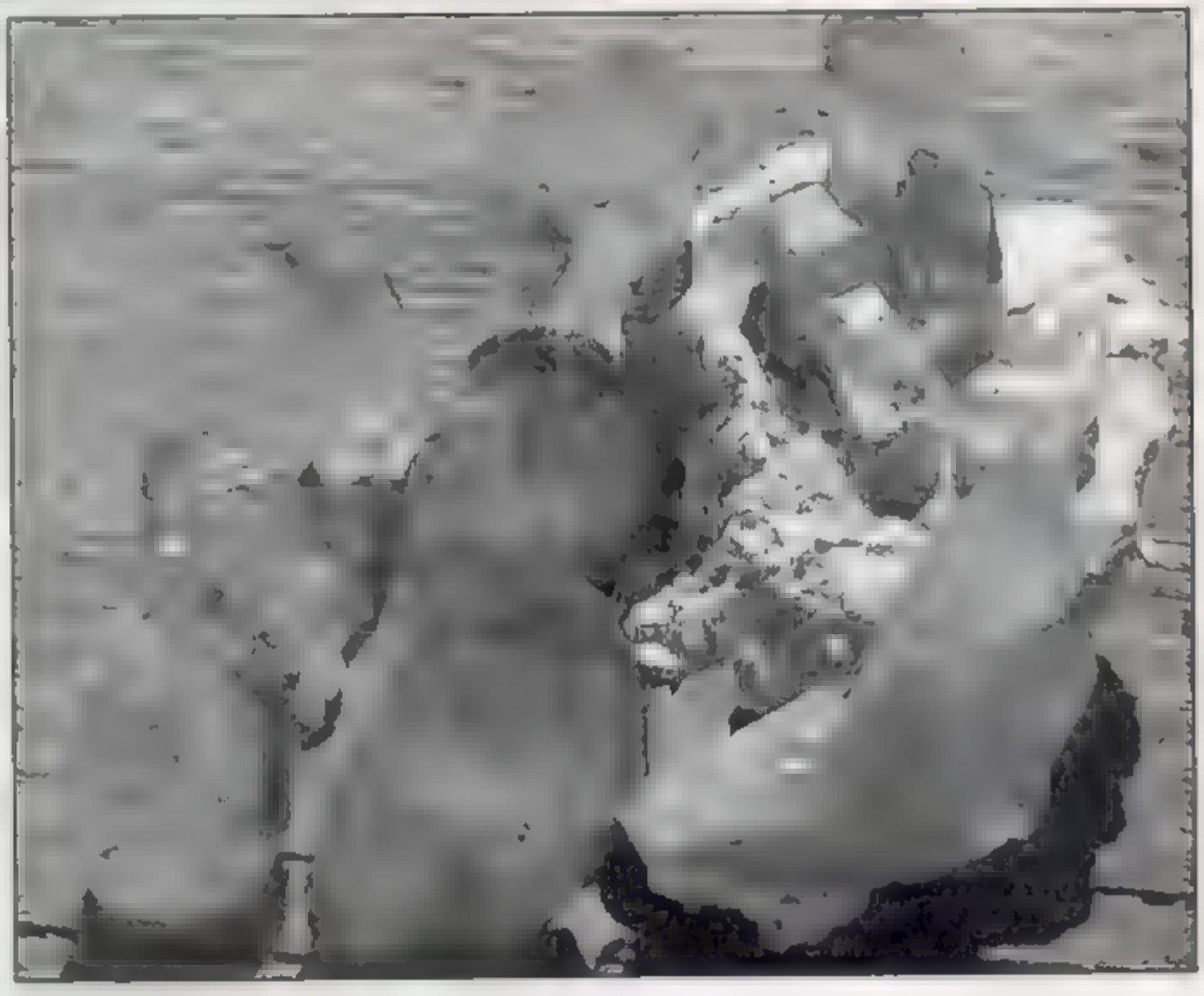
The heavy equipment work encouraged me to look around the outside of the pit, where I found a quartz crystal cluster with tiny, yellow, tabular crystals that looked familiar. The little yellow tabs were identified as stolzite crystals.

Stolzite is a rare mineral that is often identified as wulfenite unless chemical tests are done to show the presence of tungsten. Stolzite is a member of a "solid solution series," with wulfenite (lead molybdate) being one end member and stolzite (lead tungstate) the other end member. After cleaning, this specimen turned out to be my best example of this interesting mineral, with many little tabular crystals sprinkled on a quartz crystal matrix. Gary speculates that the tiny cream-colored crystals all around it may be pyromorphite.

Speaking of tungsten, Gary told us that scheelite has also been reported from the Fat Jack, but I don't know anyone who has found any of those sharp, fluorescent, octahedral crystals at this location. Other collectors were excited about my stolzite find and hoped to find specimens for themselves. Together, we walked over to the area above the main workings where I had picked up my specimen. As we searched, some friends joined us and poked around a bit. Several lovely quartz crystals were found, but no more stolzite. Fickle minerals, aren't they?

Gary called us all down into the pit, where he described how to search for a vug at the Fat Jack. In particular, he recommended looking for the sticky clay that filled the pockets, protecting the crystals, and digging along the seams of red iron oxide that marked the ancient cracks in the pegmatite.

Soon, that bad dog must not have cap



There are plenty of nice quartz crystals to be found at the Fat Jack Mine. They were considered waste material by the mine's original owner, Fat Jack Campbell, who sought gold and silver.

This amethyst scepter holds a much older quartz crystal, formed before the amethyst layers were deposited.

tured many of us, and we began to attack the earth with shovels, garden tools, screwdrivers and geologists' picks, and crystals covered with sticky mud began seeing daylight. A lucky collector called to us from the rim of the pit and showed us a lovely 4-inch-long scepter crystal he had found on the surface in the old tailings. I wondered if DNA testing would show evidence of flesh from old Fat Jack's barked up knuckles.

Gary fired up the tractor and dug a dump-truckload of dirt out of the most productive area in the pit for us, and foundation members began burrowing in it with a vengeance. As we dug, we chatted about collecting areas we had discovered, and rediscovered, and friends who collected with us.

We would loosen up the mud with whatever small tools we had available, paw through the material without caring how badly we were cutting our fingers, then proudly hold up each crystal as its facets were revealed beneath that covering of sticky clay. The pain in my fingertips is reminding me of that happy time as I touch-type each letter of this story!

Too soon, it was time to get back to town with our muddy treasures. I rode to my van with Tom and TJ, and on the way we met Darrel Dodd coming up to the mine. He had made a late start, but this was one trip he wasn't going to miss! We

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by Bob Jones

Gems in Space and Other Mineral Weirdness

It's hard to believe that lowly bacteria made possible such stunning cave formations as these in Carlsbad Caverns. (Photos by the author)

When you want to talk about rocks, you pretty much have to stick to the Earth, or in rare cases, the moon. So if I were to ask you where the largest deposit of gems is, you might mention Sri Lanka or Brazil or Siberia or wherever. You'd be wrong, because that's a trick question. If you really wanted to get to the largest deposit of gems—sapphires, diamonds, spinels, rutiles, and more—just don a space suit and head for the stars!

Now we all know that the stars start out as simple hydrogen and, through nuclear fusion, get to the business of creating elements. Our own sun, for example, is the proud producer of well over 60 elements that we know of. But gems? Hardly!

Still, astronomers have come up with some pretty radical findings lately, and maybe the most radical is that the space dust that is found around some stars just might be particles of our favorite gems, the aforementioned diamonds, sapphires and the like. Next thing you know, they'll tell us dinosaurs still exist. Just kidding!

If you think the idea of gems floating around in space is weird, here's another one for you. We have always thought that caves are formed when watery solutions, carrying slightly acetic carbonic acid, wend their way down through cracks in limestone, gradually eating away the rock and carrying off the dissolved minerals. This is true, up to a point.

Scientists are now saying that a few caves have been formed by bacteria! They even mention the Big Room at Carlsbad Caverns as a prime example of a cavern resulting from bacteria, not from dissolution by water. Now I've been in that huge chamber and to even imagine that microscopic rock-eating bacteria could have gouged out that cave seems ridiculous. Still, after teaching science for 30 years and writing articles for over 40 years, I must say I have learned never to doubt out of hand what scientists say. It turns out that the bacteria isn't eating the rock, but they are the culprits who trigger the process. So, let's see about the outer space gem fields and inner space rock-eating bacteria.

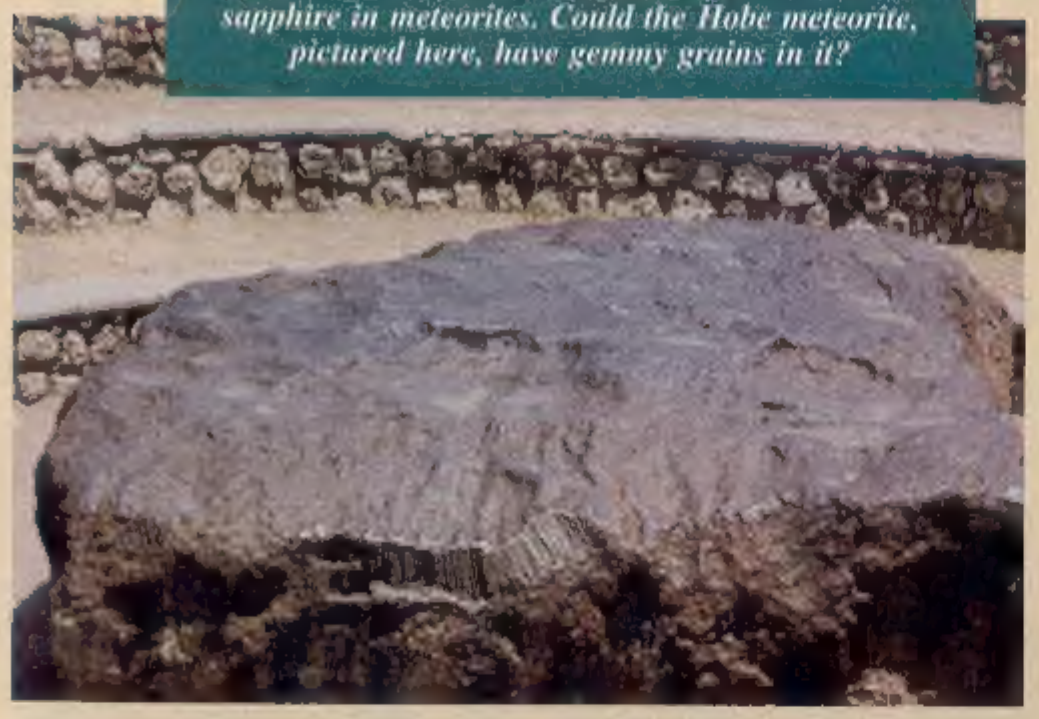
The gems in space idea came about when we were able to get all sorts of exotic instruments into space for a good look at what's out there. Earth-based telescopes had long ago revealed that space is loaded with dust, the debris from exploding stars. We can even look at bright remains of stars that exploded and check the composition of the resulting dust.

We now know that stars are the nuclear factories for making elements and these, in turn, can join to form compounds, especially when the star reaches old age. As a star uses up its hydrogen fuel, it gradually expands and expands, passing through various stages of color. Our sun, for example, is a middle-aged star, so it is yellow. Younger stars are bright blue-white, while stars older than our sun become more red and often expand to giant proportions. When our sun becomes what we call a red giant it will engulf virtually the entire solar system. What's important about these red giants in explaining gems in space is that some of them seem to be surrounded with gemstones in the form of space dust.

How do we know this? It really started with meteorites. When we began to take these space visitors apart, we found microscopic diamonds and other gem minerals locked inside them. Granted, the diamonds were exceedingly small, the largest thought to be about 1 micron. That's $\frac{1}{1000}$ of a millimeter. Most are far smaller than that—hardly facetable!

The next big discovery in meteorites occurred about five years ago when scientists found particles of aluminum oxide in meteorites. If you recognized that as the composition of sapphires and rubies, you're right.

With the installation of various instruments and telescopes in space, scientists could now study what was going on in stars with-



Scientists have found tiny grains of diamond and sapphire in meteorites. Could the Hobe meteorite, pictured here, have gemmy grains in it?

This is a superb example of ludlamite on pyrite from high in the Bolivian Andes.

out the interference caused by Earth's atmosphere. The most important method of study was to identify the size of infrared wavelengths being emitted by space particles. Keep in mind that the material being studied was the debris of stars and still exceedingly hot. Each element or compound gives off an infrared "fingerprint," if you will. When scientists launched an infrared-sensing satellite and turned it on, all sorts of goodies were identified, including sapphire, rutile, peridot, diamond, and even such lowly minerals as calcite and dolomite. Again, all these compounds only exist in tiny bits ranging from a few molecules to a few microns across, but they do exist and in vast quantities. It has been estimated that in just one region of space there could be tens of thousands of tons of sapphires or diamonds or whatever that particular star region happened to produce.

Is there a chance a field trip in space might ever happen? Not in the next few thousand years. So, you better hang on to your hiking boots and rock pick!

As for the bacteria eating away at limestone to form a cavern of enormous size, it's not quite that simple. What aroused scientists' curiosity about some caves was that they were made up of huge cavernous rooms but there was no evidence that water had traveled through them to carry away the dissolved rock. After all, if you are going to dissolve thousands of tons of rock the water that carries the rock in solution has to go somewhere. So, if no exiting channel could be found where could that rock-carrying water have gone?

The answer evolved first of all at Carlsbad Caverns in New Mexico, one of America's best-known cave systems. If flowing water, slightly acidic from dissolved carbon dioxide, had eaten away the chambers, where did the now mineral-laden water go? Scientists and spelunkers have never found any place where flowing water could have escaped the Carlsbad system. The conclusion was that there is no exit channel. That presented scientists with a real puzzle. Water can evaporate, but not through solid rock!

It so happens that deep in the Earth below Carlsbad there are petroleum deposits, and scientists know that in such deposits there are always myriad petroleum-eating bacteria. As with any other living thing, the bacterial process of eating releases a gas. In the case of these bacteria, the product is hydrogen sulfide, that good old rotten egg-smelling gas.

As a gas, hydrogen sulfide could work its way up through cracks and joints in the limestone until it came in contact with groundwater trickling down from above. This contact could turn very weak carbonic-laden waters into a very much more potent sulfuric acid, what we used to call battery acid. Sulfuric acid is many times more powerful than carbonic acid in dissolving limestone. And it wouldn't take much water combining with the sulfuric acid to do a powerful lot of dissolution. Put carbonic acid water on limestone, and you can watch the tiny reaction bubbles form a few at a time and slowly rise to the surface of the liquid. You can stick your finger in the bubbling liquid and you may feel a slight tingle. Put sulfuric acid on the same piece of limestone, and you see a violent frothing and churning reaction that obscures your view completely. Stick your finger in the frothy reaction, and your skin will be attacked! No wonder huge limestone chambers could be dissolved by sulfuric acid. But still, the dissolved rock has to go somewhere. The fact is, it stayed in the cavern as it formed.

Is there any evidence of this reaction other than observation? One of the byproducts of the reaction between limestone and sulfuric acid is a familiar mineral, gypsum. This soft but relatively insoluble mineral is found in considerable abundance at Carlsbad. Its volume is much less than that of the original limestone, so open spaces resulted.

Scientists who devised this theory began checking other caves, and in every instance in which a cave was in close proximity to a petroleum deposit, lots of gypsum was found. The obvious conclusion was that bacteria were working their smelly magic on the limestone.

In summary, it looks like a very small percentage of cave systems owe their existence to petroleum-eating bacteria and the resulting sulfuric acid attack. From my point of view, the intrinsic beauty of a cave, regardless of how it formed, is enough reason for me to go underground every chance I get. And frankly, I'm not so sure I feel that way about going into space in search of sapphires!

* * *

About the time you get this copy of *Rock & Gem*, you'll be making plans to go to Tucson and enjoy the shows there. At least, I hope you will. The Main Show, Feb. 13-16, will feature "Minerals of the Andes." You can expect to see marvelous examples of bright-red rhodochrosite, gem emeralds, stunning yellow-violet ametrine, rare copper species, wire silver from high in the Andes, lustrous cassiterites, tretrahedrites, vivianites, superb pyrites, and chalcopyrites, along with a host of beautiful gangue minerals like calcite, quartz, dolomite, fluorite and the like. After all, the Andes have been penetrated by humankind for centuries, yet they are still producing marvelous gem and mineral specimens. The Colombian emerald deposits, for example, are estimated to hold at least another 500 years of production. Clearly, the Andes are a rich mineral province that produces a vast array of fine species.

While attending the Tucson Gem & Mineral Society (TGMS) Show, you are also invited to come to our free reception Wednesday evening, Feb. 12, at 7 p.m. The plan is to have Michael Scott, a premier gem collector, as a speaker. Michael's gem collection has been featured at the Bowers Museum of Cultural Arts in Santa Ana, California. The collection rivals most publicly owned collections. His lecture will be a real gem. The Wednesday evening reception has become the social event of the show week, for its gives you a chance to visit with friends without the hubbub of buying and selling. Refreshments will be served. The reception is free, but you have to make a reservation by calling (520) 471-0499. See you there!

Collecting at the Fat Jack Mine *from page 91*

pulled the truck up on the side of the hill so he could pass, then continued to the parking area. I asked if Tom would follow me back to the highway, as I was afraid I might have damaged my van in the earlier exploration phase of the trip. Down from Crown King we bounced, pulling over several times for upward-bound traffic. When I got to the base of the mountains, I heard the ominous slapping of a flat tire. My rear tire had been cut to shreds by the sharp rocks of the primitive road. By the time my escort caught up with me, I had the tire off and the spare almost on. I was sure glad to have company as I drove many more miles of bad desert road without a spare! My new friends followed me all the way back to Phoenix down busy Interstate 17.

When I got home, I put the garden hose in my collecting bucket and washed away about 5 pounds of mud that was clinging to the specimens, then spent several hours cleaning each one individually. I put doubly terminated crystals in one box and crystal clusters in another, leaving the leaverites in a big pile by my back door. After sorting out the hunks of rock, I had well over 100 single crystals, several of them good enough for my personal collection. The rest would be shared with my geology club kids and anyone else who showed an interest. I had also collected stolzite, schorl tourmaline, dolomite (or is this ankerite?), and the porcelainlike massive mineral osarizawaite.

I had also found an unknown (to me, at least), unusual, fibrous green mineral similar in appearance to malachite. Harvey Jong said if I couldn't identify it, I shouldn't include the picture in this story, so I finally did what I should have done in the first place.

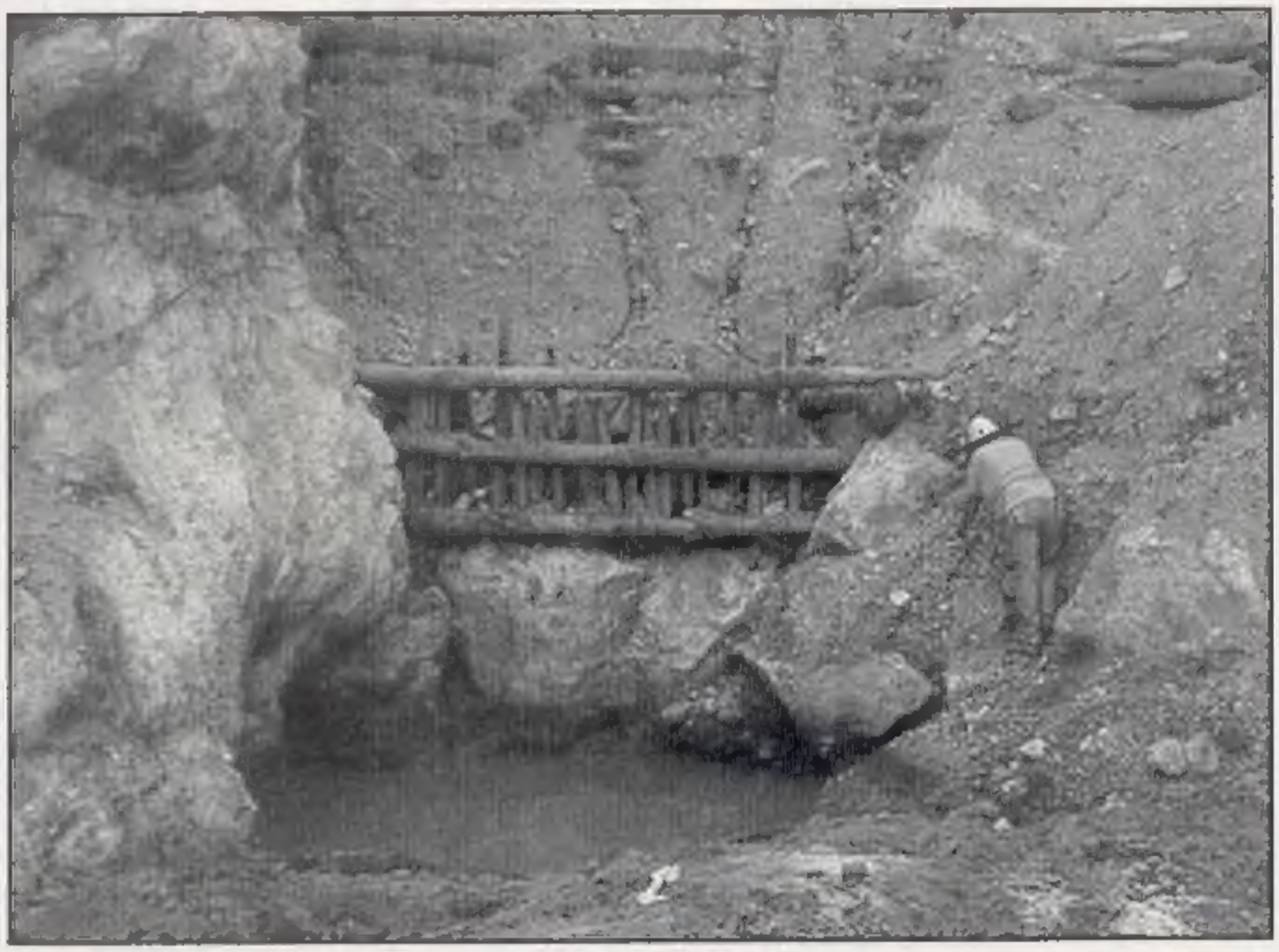
Yes, I channeled the knowledge of Frederick H. Pough. First, I got out my copy of Dr. Pough's *A Field Guide to Rocks and Minerals* and a Fat Jack scepter. I placed the crystal on page 156 to hold the book open. Dr. Pough says if it's green and fibrous and bubbles when you put a tiny drop of hydrochloric acid on it, then it is malachite—unless it quacks, in which case it is a mallard duck. Using a little toothpick dipped in a very small bottle of diluted hydrochloric acid, I placed a tiny drop on a beat-up crystal on the back of the specimen. It bubbled away like the peroxide I used on my poor fingers after the trip, so I knew it was malachite. Gone now are my visions of mineralogical fame and the admiration of posterity. Oh well.

I got another surprise when I was throwing my leaverites in a bucket for disposal. I noticed some little butterscotch-colored crystals on a rough quartz crystal group. When I looked more closely, I saw they were bi-pyramidal stolzite crystals like you see in the European mineral books!

Steve Decker looks on as Foundation member Ray Grant examines the author's stolzite specimen.

I would definitely say I got my money's worth out of this collecting trip! If you would like to take a trip to the Fat Jack Mine, contact Gary and Nancy Spraggins (1928 E. Colgate Dr., Tempe, AZ 85283, (480) 838-2131, email: free bird@shakras.com). They will provide you with good directions to a convenient meeting place near the mine.

More information on the Fat Jack Mine can be found in the *Mineralogical Record*, Vol. 22, issue 1, January 1991; back issues are still available. If you would like to see more pictures of the Fat Jack Mine, check out the Virtual Collecting Trip that our Webmaster, Harvey Jong, has placed on the Foundation's Web site, www.AzMinFun.com. We have the Technology! We have the Knowledge! And we have the Rocks, both in our collection and in our heads!



The old shaft from gold-mining days is a rubble-filled gray area in the country rock wall, held back by pine-log shoring.

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